APPENDIX D: SUMMARY OF CURRENT INFORMATION ON FIRE REGIMES IN THE KLAMATH REGION

1.1. FIRE REGIMES IN THE KLAMATH MOUNTAINS: RECONSTRUCTING AND INTERPRETING FIRE REGIMES

(Excerpted from Frost, E. J. and R. Sweeney. 2000. Fire regimes, fire history, and forest conditions in the Klamath-Siskiyou region: an overview and synthesis of knowledge. Report prepared for World Wildlife Fund. url: ***http://www.worldwildlife.org/forests/attachments/fire_report.pdf*** **(viewed 13 April, 2004). Reproduced and updated here with permission from the Authors and World Wildlife Fund.**

The role of fire in shaping the vegetation and biota of the Klamath Mountains can be assessed by understanding how these ecosystems interacted with fire in the past. Historical conditions or processes are most often characterized in terms of fire regimes, which are described in terms of ignition, frequency, severity, seasonality and spatial extent of fires occurring in a given area (Agee 1993, 1990). Fire regimes can vary considerably by vegetation type and between landscapes, and provide a generally accepted way to categorize areas for study and management purposes (Smith & Fisher 1997, Skinner & Chang 1996, Agee 1994).

Measures of historic fire regimes (e.g. length of fire return interval, severity of fire effects, size of area burned) provide a biophysical baseline – often referred to as "reference conditions" – against which current conditions and proposed management can be assessed. Increasingly, reference conditions derived from historic information are being used to create ecologically justifiable goals for forest management and restoration (Moore *et al.* 1999, Stephenson 1999, Kaufmann *et al.* 1998, Fule *et al.* 1997, White & Walker 1997, Manley *et al.* 1995). However, some researchers have expressed concern that historical conditions may not represent valid reference points for the current climatic period (Millar & Woolfenden 1999). Broad consensus appears to be emerging that managers should use historical ecology to guide the general direction rather than the precise details of restoration treatments (Landres *et al.* 1999).

Most of our knowledge of long-term fire regimes is restricted to what can be derived from analysis of fire scars preserved within the annual growth rings of old trees (Agee 1993, Arno & Sneck 1977). Depending on the spatial extent of sampling, fire histories from fire scar analysis can be related to individual tree, forest stand or landscape scales. Most studies summarized in this report represent stand-level fire histories, meaning that they are based on information collected from multiple fire-scarred trees in an area of several hectares or less. Fire history information for small, specific sites is useful for comparing fire effects within and among different vegetation types, but it does not provide much information on how fire would have influenced landscape dynamics spatial patterns. Very few landscape-scale studies have been completed in Klamath forests (Taylor & Skinner 1998).

Relatively few fire history studies have been completed in the Klamath Mountains compared to neighboring forested regions (e.g. Sierra Nevada, Cascades). Within a particular forest type, generally only a few different sites have been studied, and these fail to represent the full range of regional variability that exists within these forests. Table 1 summarizes fire history information from various published and unpublished sources for the Klamath Mountains and areas in adjacent regions that have somewhat similar vegetation and climate. Data are presented by forest type, based on the dominant tree species reported. The spatial extent of the area sampled is given to facilitate comparison and convey variation in methodologies used. The data summarized represent a period that generally encompasses several hundred years prior to Euro-American settlement.

Not surprisingly, fire histories of the forest types that occur in the region have not been equally studied. Most publications concentrate on the commercially valuable mid-montane Douglas-fir and mixed conifer forests, whereas very little of the literature includes data on foothill/lower montane, upper montane/subalpine zones and forests associated with riparian areas and ultramafic soils. Similarly, some fire regime characteristics (e.g. fire frequency) have been documented much more than others (e.g. fire size, severity). The remainder of this section will summarize what is currently known about each of the fire regime characteristics in the Klamath Mountains, followed by more specific information for the region's major forest types. Forest types are categorized into general groups based on their elevation range and geographic location.

1.2. FIRE IGNITIONS

Lightning and humans are the two sources of fire ignitions that occurred historically and continue to occur in the Klamath Mountains. Lightning strikes are frequent across most of the region during the summer and have a sufficiently high density to ignite numerous fires (LaLande 1980, Cooper 1939, Morris 1934). Agee (1993) reported that the Siskiyou Mountains exhibit the highest patterns of lightning occurrence in the Pacific Northwest, as much as twice the number of lightning ignitions that occur in either the Cascades or Olympic Mountains (Agee & Flewelling 1983). The higher number of lightning ignitions are due to both increased lightning frequency and decreasing summer precipitation patterns characteristic of the Klamath-Siskiyou region.

July and August have been reported as the months of greatest number of lightning strikes, but August and September have the highest proportion of actual lightning-caused fire ignitions. The low probability of precipitation during the season of lightning occurrence probably allows fires to die down but not be extinguished during periods of low winds or moderate weather, and remain capable of renewed spread under patterns of windier or warmer weather.

Some lightning storms are very localized while others are regional in extent. The regional storms can ignite hundreds of fires almost simultaneously and can easily overwhelm fire suppression capabilities. For example, during the major fire episode of 1987, more than 1,600 lightning strikes were recorded during a twelve hour period in late August in southwest Oregon alone, leading to ignition of 600 fires (Helgerson 1988). These and similar strikes in northwest California led to fires on almost 400,000 hectares in the region (Walstad 1992). According to Atzet *et al.* (1988), essentially all of southwestern Oregon is sufficiently saturated with lightning to ensure that all sites will have the opportunity to burn if fuels are present and dry.

Anthropogenic (human-caused) ignitions have also been important in many forest types of the Klamath-Siskiyou region and can be divided into those started by Native Americans and white settlers. While the exact extent and frequency of Native American ignitions remains unknown, it is clear from historic accounts that most tribes used fire for many reasons. Indian burning appears to have been most frequent in low-elevation oak woodlands, prairies in the coastal forest belt, and eastside ponderosa pine/Douglas-fir forests (Sugihara *et al.* 1987). Aside from these generalities, it is not possible to separate the role of Native American ignitions from lightning sources over the last several thousand years. The most common belief is that while Native American ignitions were locally important, lightning was responsible for a large majority of historic fires and is sufficient to explain long-term fire regimes (Swetnam & Baisan 1996, Agee 1991b, Burke 1979).

After Euro-American settlement, the relatively stable areas of land burned on a regular basis by Native Americans was replaced by accidental and land use fires ignited by white settlers (LaLande 1995, 1980, McKinley & Frank 1995). Beginning in the mid-1800’s and through early decades of 20th century, miners and ranchers were responsible for frequent ignitions, often during periods of extreme summer fire weather. These settlement fires differed in terms of periodicity and seasonality from fires set by Native Americans (LaLande 1995; see section on European settlement). Historical data from 1900 to 1969 for the Rogue River National Forest indicate that between 10 – 60% of fires per year were human-caused (Brown 1960). Contemporary human-caused ignitions tend to occur along travel routes and in highly accessible/developed areas where people are concentrated (USDA Forest Service 1998, 1996, Burke 1979).

1.3. FIRE FREQUENCY

Fire frequency, typically expressed in terms of the fire return interval (FRI), is the most commonly reported attribute of the fire regime. The FRI integrates fire occurrence frequency and fire size to describe the period of time it takes for fire to burn most or all of a unit area of land (Agee 1993). In most fire history studies, multiple fire-scarred trees are sampled at each site, and when fire scars have been dated, the mean or median period of time between all recorded fires is computed. While many studies have reported means as a statistic of central tendency, medians are more appropriate for fire history studies because FRIs are often not represented by a normal distribution (Skinner & Chang 1996). In addition, the pattern of fire return intervals often varies from period to period, and therefore a simple mean may not be representative of longer records (Swetnam 1993).

Some of the data on fire frequency reported for the Klamath Mountains should be interpreted with considerable caution because of methodological problems and potentially erroneous assumptions. For example, fire return intervals reported by Atzet & Martin (1992) and White *et al.* (in press) are based on specific age classes of trees that are assumed to indicate dates of historic fires, rather than on analysis of fire scars. While regeneration of shade-intolerant tree species may be expected to increase after fire, some evidence suggests that tree age cohorts can not be reliably correlated with fire events in the Klamath-Siskiyou region (Stuart & Salazar in press [2000], Tom Sensenig, Medford District BLM, pers. communication). Other variables, such as seed availability, post-fire weather, and variations in soil conditions may also obscure fire-induced patterns of stand development.

Other studies may have produced biased fire return intervals because of a small sample size or restricted location of the study area. The FRI statistic is sensitive to the area sampled, therefore, to make relative comparisons, the spatial scale of sampling has to be taken into account (Agee 1993). The return intervals reported here (Tables 1 and 2) are mostly point or plot composites, which means they are the sum of fire intervals for several to many trees at sites of one to several hectares in size. However, a few studies calculated fire return intervals for significantly larger areas, up to 91 hectares in the Klamath-Siskiyou region (Agee 1991a), and larger for some studies conducted in the southern Cascades. Variation in size of area for which fire return intervals are calculated makes comparisons between some studies problematic.

Given these caveats, available studies indicate that median fire return intervals in forests of the Klamath Mountains vary considerably with forest type, ranging from as high as 140 years in Douglas-fir/mixed conifer forests (van Norman 1998) to 10 years or less in tanoak, jeffrey pine (White *et al.* in press) and ponderosa pine/Douglas-fir (Taylor & Skinner 1994; Table 1). Both subregional and forest type differences are evident, but overall, fires were moderately frequent, averaging between 15-40 years in 19 of the 32 fire return intervals that have been reported. Generally, it appears that fire frequency increases from west to east and from higher to lower elevations (Atzet & Wheeler 1982). Mean or median return intervals for forest types primarily associated with the coastal subregion (coast redwood, western hemlock, and Port Orford cedar) are at least 50 years, and are often likely to be considerably longer. Although no data are presented, Atzet & Wheeler (1982) estimate that the fire-free period varies between 100 – 200 years in the coastally-influenced portion of southwest Oregon. Similarly, Veirs (1985) reports that fire frequency in the North Coast Range of California is much lower than inland areas, due to the maritime influence on relative humidity and fuel moisture. The frequency of lightning ignitions is also known to decrease with closer proximity to the coast (Stuart & Salazar, in press [2000])

Variation in fire return intervals from one study area to another within the same forest type is often significant. Within Douglas-fir/mixed conifer forests, for example, average intervals between fires vary from modal values of 15 years (Taylor & Skinner 1998) to 120 years (van Norman 1998). Furthermore, the large majority of studies show considerable variation in fire frequency within individual study areas. Stuart & Salazar (in press [2000]) report a mean FRI of 39 years for white fir *(Abies concolor*) forests in the western Klamath Mountains, with a range of fire-free periods from 12 to 161 years. Other studies conducted in the region report similarly wide ranges in the intervals between fires, which overall appear to be wider than those from similar forest types in the southern Cascades (Table 1) and Sierra Nevada (Skinner & Chang 1996).

Ecologists have recognized that the variation in intervals between fires at any one site may be more critical than average intervals to understanding the effects of fire over time on vegetation (Taylor & Skinner 1998, White *et al.* in press, Skinner 1997). For example, one 40 year interval between fires on a site is sufficient to allow shade-tolerant tree species (e.g. white fir, incense cedar) to establish and grow to a size where they are relatively fire-resistant (Agee 1993, Taylor 1993, Sugihara & Reed 1987). Fire-free periods of this length have been reported in many Klamath fire history studies, even in forest types with relatively high fire frequency (White *et al.* in press, Taylor & Skinner 1998, Adams & Sawyer 1980). Christensen (1985) proposed that species diversity in many ecosystems may actually depend on such variation. Ecological process modeling (Keane *et al.* 1990) indicates that vegetation and fuels would be significantly different from pre-settlement patterns if fire return intervals were regular, without variation.

The wide variation in fire return intervals characteristic of fire regimes the Klamath Mountains has been attributed to the effects of topography, elevation, weather, fire regimes in adjacent areas, and chance (Moir & Mowrer 1995, Brown 1994, Agee 1991a). Cursory examination of the data in Tables 1 and 2 suggests that forest types with the greatest variability in fire return intervals tend to occur in more mesic environments and at higher elevations. Moister sites (e.g. coastal areas, canyon bottoms, north-facing slopes and higher elevations) are less likely to have fuels sufficiently dry to burn as on drier sites or south-facing slopes (Heyerdahl *et al.* in press, Teensma 1987, Kilgore & Taylor 1979). Some studies have found at least a weak correlation between topographic variables (aspect, slope steepness, slope position) and fire frequency (Taylor & Skinner 1998, 1997, Key 2000), while others have not (White *et al.* in press, Cissel *et al.* 1999, van Norman 1998). Refer to Tables 1 and 2 and the next section of this report [Appendix] for more information on variation in fire frequencies associated with particular forest types.

1.4. Fire Intensity and Severity

Fire intensity and severity are two terms associated with the magnitude of fire effects, but have distinctly different meanings in the fire ecology literature. Fire intensity is defined as the amount of energy released from a fire, and may or may not be directly related to effects of fire on the biota. Descriptive measures of fire intensity include the mass of fuel consumed, and the rate of spread of the fire, and the position of the fire front within the forest profile (ground, subcanopy, overstory). The following discussion will focus primarily on fire severity.

Fire severity is a more qualitative measure of magnitude used to describe the degree to which vegetation and site conditions have been altered by a fire. This attribute generally reflects mortality of dominant tree species present in a given area, and is useful in recognizing the variability in fire that occurs within or between fires. Three levels of fire severity are typically recognized in the literature (Agee 1994, 1993, Wright & Bailey 1982):

High severity – Most trees, including overstory trees, are killed.
Moderate severity – Partial stand-replacement fires that include areas of both low and high severity. Some overstory trees are killed or heavily damaged in high severity patches.
Low severity – Light surface fires that have minimal impacts on forest overstories, but may kill small trees and shrubs.

It is usually not possible to measure historic fire severity directly. Inferences are generally drawn based on patterns of fire return intervals, stand age class structures and species composition.

In general, there is an inverse relationship between fire frequency and severity; longer intervals between fires allow for a greater accumulation of fuels that lead to hotter, more severe fires when ignited (Agee 1993). Since most of the forests in the Klamath-Siskiyou region burned at moderate to high frequencies, it follows that most fires produced moderate to low-severity effects on the vegetation. Examination of early historical accounts of fires in the Klamath Mountains generally supports this conclusion (LaLande 1995, McKinley & Frank 1995, Morris 1934). Evidence collected from dendrochronology studies indicates the dominance of moderate or “mixed” severity fires (Tables 1 and 2), where a complex, irregular pattern of tree mortality and openings are created. The patchiness associated with moderate severity fires has been instrumental in promoting species and habitat diversity in the Klamath-Siskiyou region (Sapsis & Martin 1993, Martin & Sapsis 1992).

Within an individual fire, severity is a result of the complex interaction of many temporal and spatial factors including forest structure, fuel availability and moisture, topography, weather, and fire behavior in adjacent areas (Heyerdahl *et al.* in press [2001]). Patches of high tree mortality, ranging in size from individual trees to hundreds of acres, are thought to have been relatively common and occurred in areas with heavy fuel accumulations sometimes reinforced by steep slopes or extreme weather conditions (van Norman 1998, Wills & Stuart 1994, Stephenson *et al.* 1991, Agee 1991a). Fires would be most likely to burn at low intensity during cool nights, periods of mild weather, in areas with low fuel loads, and/or under mesic conditions (Agee 1991b). Larger stand replacement fires probably occurred in moderate severity fire regimes, but at relatively long intervals (>300 years) and likely under extreme fire weather conditions (Stuart & Salazar in press [2000], Atzet & Wheeler 1982).

White *et al.* (in press) found that forest types characterized by low-severity fires (e.g. Jeffrey pine and mountain hemlock series) were generally drier (mean annual precipitation) or cooler (mean annual temperature) than forests with more moderate intensity fires (e.g. tanoak series). They suggested that fire severity may be correlated with forest productivity, because fuels accumulation is more limited in dry and cool environments. Taylor & Skinner (1998) found that fires tended to burn at higher severity on upper slopes, ridgetops and south- and west-facing slopes than lower slopes or east- and north-facing slopes. Fires on sites with rocky or very shallow soils with scattered trees, such as those often found in canyon live oak or subalpine forests, result in little mortality due to lack of fuels (Agee 1993).

These historic patterns of fire severity are consistent with observations of recent fires in wildlands of the Klamath Mountains, many of which continue to burn in a mosaic pattern and result in varying levels of tree mortality. For example, of the 38,200 ha affected by the Silver Fire in southwest Oregon, 9% was high severity, 32% was moderate severity and 59% was low severity (USDA Forest Service 1988). Patches of high mortality were generally less than several hundred acres. The 1994 Dillon Fire on the Klamath National Forest, and the Big Bar and High Fire complexes that occurred in 1999 on the Shasta-Trinity National Forest also burned as primarily low-severity fires with varying-sized stand replacement patches (USDA Forest Service 1999). Additional discussion on the potential change in fire severity from the pre-settlement to contemporary era will be presented later in this report.

1.5. SEASONALITY

The vegetation found within a particular ecosystem has generally adapted over long period of time to the season(s) in which fires generally occur; therefore the seasonality or timing of fire occurrence can be very important in determining fire effects (Skinner & Chang 1996, Agee 1993). For example, spring burning occurs at a time when buds are flushing and are much more susceptible to damage than fires burning in summer or fall (Parker 1987).

The position of fire scars within annual growth rings (e.g. late wood vs. early wood) of trees is commonly used to provide an estimate of the season of past fire occurrence (Dieterich & Swetnam 1984). Data on seasonality of fire is limited in forests of the Klamath Mountains – to date, only a few studies have investigated this fire regime characteristic. In general, seasonal fire scar positions have been found in the latter portions of annual rings, indicating that most fires occurred late in the growing season, from mid-summer to early fall. This is consistent with typical lightning patterns observed in the region, with most of it striking in the late summer (Automated Lightning Detection System 1999).

After being ignited in July and August, many fires appear to have the ability to spread over weeks or months, with periods of smoldering or slow progression alternating with aggressive runs when weather becomes hot or windy. Morris (1934) quotes the Jacksonville newspaper in 1864: "during the past few weeks…the fires [in the Siskiyous] have been raging with increasing fury". About 70% of recent large fires in the two most northwestern California counties burned during August and September (Gripp 1976). Large fires may burn until autumn rains arrive in October or even later, as was the case with the 1987 wildfires that burned into November (Helgerson 1988).

Although the greatest number of fires and large fire events occur in late summer and early fall, the climate is variable enough to allow occasional fires during favorable periods in the late spring and early summer, particularly on warm, dry sites (C. Skinner, Pacific Southwest Research Station, pers. communication). The more xeric, low-elevation forest types, including interior oak woodland, ponderosa pine, and jeffrey pine are the forests that are most likely to burn early in the fire season, especially those on southerly aspects. The shorter duration of snow cover on south aspects results in longer periods during which fuels are sufficiently dry for fires to ignite and spread (Heyerdahl *et al.* in press [2001]).

1.6. SPATIAL EXTENT AND LANDSCAPE PATTERN

The spatial extent of past fires refers to the size of the area affected by a fire and the landscape patterns that are created as a result (Agee 1993). Fire extent is difficult and time-consuming to determine in ecosystems characterized by mostly low- and moderate-intensity fires, because it requires numerous cross-dated fire scars from a wide area of the landscape, from which deductions of past fire extent can be drawn. But even this technique is incomplete because such fires would not have scarred every tree within the fire perimeter. In forests that burn with high severity, fire extent may be obvious for a century or more from the mosaic pattern of different-aged stands (Agee 1993).

Relatively few of the fire history studies conducted in the Klamath Mountains have presented data on the spatial extent of fires. Agee (1991a) found that mixed severity fires in Douglas-fir and white fir forests of Oregon's Siskiyou Mountains were historically small to intermediate sizes, ranging from 86 to 576 hectares. Working in similar forest types in northwest California, Taylor & Skinner (1998) reported a mean size of 350 ha. for historical fires, with a range of 28 to 1340 ha, and suggest that large spreading fires are characteristic of Douglas-fir dominated forests in this region. Most of the fires that burned in the 45,000 hectare Little River watershed (near the northern boundary of the Klamath-Siskiyou region) were between 10 and 400 hectares, with a few up to 3,000 hectares in size (van Norman 1998). The dominance of small and intermediate-sized fires in the Klamaths is similar to findings from nearby regions with similar vegetation and climate (Table 1).

The range of variability in spatial extent of historic fires is important in understanding fire as an ecosystem process. Evidence of fire sizes taken from giant sequoia groves in the Sierra Nevada indicates that when fires were more frequent, they appear to have been relatively small and patchy, but during periods of less frequent fires, they were larger and generally more continuous (e.g. drought; Swetnam 1993). Large fire years are often associated with regional events and extreme climatic conditions (McKelvey & Busse 1996, LaLande 1995, Morford 1970). According to Atzet & Wheeler (1982), very large, often stand-replacement fires occur, on average, every 200 years in coastal and western subregions. The 1987 wildfires and 49,000 hectare Big Bar fire complex that burned in 1999 are the most recent examples of this pattern.

It seems probable that the extreme topographic variability characteristic of the Klamath Mountains may help to control the extent and pattern of most fires by inhibiting fire spread (Taylor & Skinner 1998, Swetnam & Baisan 1996, Swanson *et al.* 1988). Forests in this region are typically embedded in and distributed across highly dissected terrain where rivers, ridges, serpentine barrens, and rocky outcrops interrupt the continuity of surface fuels and thereby help to limit fire size (Franklin & Dyrness 1973). In areas where forest types with different fire regimes are closely juxtaposed, the characters of each intermingle and are sometimes indistinguishable (Heyerdahl *et al.* in press [2001], Taylor & Skinner 1998, Agee *et al.* 1990). Local-scale variation in topography can affect the moisture content of fuel by influencing microclimate and can further affect fire regimes by influencing fuel continuity (Taylor & Skinner 1998, Wright 1996, Tande 1979).

The relationship between fire attributes and topography appears somewhat contradictory from the literature, with significant correlations reported in some studies but not others. Taylor & Skinner (1998) found that slopes with south- and west-aspects tended to burn more frequently and at higher severity (Key 2000) than those with north- and east slopes. Similarly, fires were slightly more frequent at low elevations, on ridgetops and steep slopes in Douglas-fir forests of the North Umpqua Basin (van Norman 1998) and western Oregon Cascades (Weisberg 1998). In contrast, White *et al.* (in press) detected no relationship between fire severity and aspect, slope or slope position in Jeffrey pine and mountain hemlock forests. In the Blue Mountains of northeast Oregon, Heyerdahl *et al.* (in press [2001]) found no difference in fire attributes between aspects where different slopes interfinger without fire barriers.

It is speculative but consistent to infer that variation in topography at the local scale at least partially explains the wide range of fire sizes and large number of patch types that are characteristic of the Klamath-Siskiyou region. Over several decades to centuries, a mid-scale watershed is likely to have experienced considerable shifting of patch locations and types. Some patches may have had dominantly young trees, resulting from areas of high-intensity fire and could be considered early successional; more often patches would be comprised of mixed age classes and species composition, resulting from numerous fire events of varying intensity. Individual trees persisted to old age within many different patch settings, ranging from dense, near even-aged stands of old trees to scattered, even solitary old trees surrounded by shrublands or other non-forest vegetation (Wills & Stuart 1994, van Norman 1998). More landscape-level fire history studies are needed in order to better understand how fire affected vegetation patterns, wildlife habitat and other attributes of ecosystems that occur at larger spatial scales.

1.7. ADDITIONAL CONCERNS ABOUT THE RECONSTRUCTION AND INTERPRETATION OF FIRE REGIMES (DENNIS ODION).

It is important to recognize that understanding of past fire regimes for many forests is complicated by methods and that there may be considerable error in these estimates (reviewed by Baker and Ehle 2001). This problem is illustrated empirically by studies of Jeffrey pine forests in Baja California, which still experience a natural lightning fire regime. Minnich et al. (2000) used a combination of aerial photo analyses and field sampling to record fire perimeters. They concluded that 52 years would be required for fire to burn, on average, one time in their study landscape. Periodic fires of variable severity were found to be the spatial process that shaped vegetation patterns and surface fires were small and relatively inconsequential. Analyses of 105 trees that recorded fire scars in the same landscape found that the trees selected for sampling (generally, the oldest, most scarred trees are selected) were exposed to only surface fires that occurred twice as frequently as the average for the whole forested landscape (Minnich et al. (2000), Stephens et al. 2003). One explanation for the discrepancy is that fire scars may be produced by lightning ignitions that spread very little before they are extinguished. Hence they do not appear on photos. This illustrates the danger of extrapolating from point locations without sufficient understanding of spatial variability. There are other concerns with fire scar data (Baker and Ehle 2001). All the data on forest fire regimes presented in Appendix D are based on fire scar data. The range in historic fire return intervals is likely much greater in portions of the landscapes from which these data were obtained than indicated by the ranges shown.

For many vegetation types (e.g. grasslands, chaparral, high elevation forests), fire is stand-replacing, and there is no record of its frequency. Fire frequency in adjacent vegetation for which there may be estimates may or may not be similar. In addition, tree ring records do not describe past patterns of patchiness created by fire. Thus, it is not possible to have descriptions of patch size or other landscape metrics describing how mixed or high severity fire regimes have structured Klamath landscape. For these and other reasons, precise estimates of past fire regimes, and the vegetation structure that resulted do not exist for heterogeneous landscapes (Veblen 2003).

Complicating matters is the non-equilibrium nature of fire regimes. They have changed constantly throughout the Holocene in the Klamath region. Thus, as climatologists and paleoecologist currently note (e.g. Millar and Woolfenden 1998, Whitlock et al. 2003, Grant and Pierce 2003), reference conditions based on fire frequencies of recent centuries are arbitrary and likely to be unrealistic targets for maintenance because vegetation and fire regimes ultimately track climate. The presettlement Little Ice Age climate has now been replaced by climate that may be warmer than the Mid-Evil warming period, when stand replacing fire was apparently more common in places that were characterized by surface fire regimes during the Little Ice Age (Stephenson et al. 1991, Grant and Meyer 2003).

1.8. Table 1. Summary of fire history studies from the Klamath Mountains and nearby areas of similar vegetation and climate.

Area and vegetation	Location	Median or *mean* FRI [a]	Range of FRIs	Fire severity and extent	Period of record	Type of record	Size of sample area	Source
Klamath Mountains								
Coastal / Lowland Zone								
Western hemlock	NF lands, across southwest OR	*~65* [b]	not reported	not reported	1560 -1990	composites of stand origin and disturbance data	0.1 ha plots (51)	Atzet & Martin 1992
Port Orford cedar	NF lands, across southwest OR	*~50* [b]	not reported	moderate to high fire severity	1340 -1990	composites of stand origin and disturbance data	0.1 ha plots (18)	Atzet & Martin 1992
Redwood	Prairie Creek, Redwood NP, CA	*10* (*8*)	2 - 37 (2 - 27)	low severity	1714 - 1962	composites of multiple trees	0.25 ha samples over 40 ha area	Brown & Swetnam 1994
Foothill / Lower Montane Zone								
Douglas-fir / tanoak	NF lands across southwest OR	*~90* [b]	not reported	> 25% of the area burned may be high severity	1400 -1990	composites of stand origin and disturbance data	0.1 ha plots (195)	Atzet & Martin 1992
Douglas-fir / tanoak	South Fork Salmon River, Salmon Mtns., CA	*13 - 22** (*10-14*)	3 - 71 (5 - 41)	mixed severity	1742 - 1987	composites of multiple trees	3 sites, 5-8 ha each	Wills & Stuart 1994
Douglas-fir / hardwood	Applegate River, eastern Siskiyous, OR	(*~17*)	12 - 59 (12 - 18)	mixed severity	1760 - 1988	composites of multiple trees, historic photos	2 ha	Agee 1991
Douglas-fir / hardwood	Several areas on Six Rivers NF, CA	*13 - 21* *(17)*	9 - 40 (10 - 40)	mostly low and moderate severity. Number and frequency of fires increased from north to south of study area.	1750 - 1975	composites of multiple trees	39 sites sampled, average of 7.85 ha in size	Adams & Sawyer 1980

Area and vegetation	Location	Median or *mean* FRI [a]	Range of FRIs	Fire severity and extent	Period of record	Type of record	Size of sample area	Source
Tanoak	NF lands across southwest OR	3 - 23	not reported	no relationship between fire severity and aspect, slope or slope position, but some correlation with elevation. Moderate severity fires occurred at high and low elevations, low severity fires at middle elevations.	1438 - 1998	stand origin and tree age data	0.1 ha plots	White et al. (in press)
Douglas-fir / oak	Oregon Caves NM, central Siskiyous, OR	*37*	not reported	mixed severity, fire size from 86-576 ha	1480 - 1989	composites of multiple trees, stand origin data	45 ha	Agee 1991
Douglas-fir / tanoak	Eastern Siskiyous, OR	*~20*	not reported	low to moderate severity	not reported	not reported	not reported	Atzet et al. 1988
Douglas-fir	Little River, North Umpqua Basin, OR	90 - 141 [c]	9 - 362	variable severity, fire size mostly 10-400 ha, few up to 3,000 ha. Fire frequency only weakly correl- ated w/topography; highest MFIs on low-elevations, ridgetops and steep slopes	1490 - 1996	composites of multiple trees	0.48 ha samples over 45,000 ha	van Norman 1998
Douglas-fir	NF lands across southwest OR	*~30* [b]	not reported	low to moderate severity	1200-1990	composites of stand origin and disturbance data	0.1 ha plots (175)	Atzet & Martin 1992
Canyon live oak / mixed conifer	Klamath Mountains (not reported)	13 (11)	7 - 39 (7 -33)	not reported	not reported	composites of multiple trees	< 1 ha	Skinner unpublished, reported in Skinner & Chang 1996
Ponderosa pine / mixed conifer	Klamath Mountains (not reported)	11 (11)	3 – 55 (5 – 46)	not reported		composites of multiple trees	< 2 ha	Skinner unpublished, reported in Skinner & Chang 1996

Area and vegetation	Location	Median or *mean* FRI [a]	Range of FRIs	Fire severity and extent	Period of record	Type of record	Size of sample area	Source
Mid-Montane Zone								
Jeffrey pine / mixed conifer	Klamath Mountains (not reported)	12 (12)	4 – 96 (4 – 96)	not reported	not reported	composites of multiple trees	2 ha	Skinner unpublished, reported in Skinner & Chang 1996
Douglas-fir / mixed conifer	Thompson Ridge, central Siskiyous, CA	12 - 19* (12 - 22)	6 - 116 (4 - 200)	mixed severity (86% low and moderate), correlated w/aspect but not slope position or forest type. Mean fire size of 350 ha (28 - 1340 ha)	1626 - 1992	composites of multiple trees	1-3 ha samples over 1570 ha area	Taylor & Skinner 1997, 1998
Douglas-fir / mixed conifer	Klamath Mountains (not reported)	13 (14)	3 – 57 (3 – 52)	not reported	not reported	composites of multiple trees	2 ha	Skinner unpublished, reported in Skinner & Chang 1996
Douglas-fir / mixed conifer	Klamath Mountains (not reported)	12 (15)	3 – 59 (3 – 59)	not reported	not reported	composites of multiple trees	< 1 ha	Skinner unpublished, reported in Skinner & Chang 1996
Mixed conifer	Shasta-Trinity Divide, CA	(*17*)	(7 - 50)	not reported	not reported	composites of multiple trees	38 sites, ~1 ha each	Skinner 1994 (abstract)
Enriched mixed conifer, riparian	Shasta-Trinity Divide, CA	16 - 42	5 - 71	low severity, significantly lower and more variable than adjacent uplands	1622 - 1933	composites of multiple trees	4 sites, 1-2 ha each	Skinner, in press
Enriched mixed conifer, upland	Shasta-Trinity Divide, CA	7 -13	4 - 64	low to moderate severity	1525 - 1924	composites of multiple trees	4 sites, 1 - 2 ha each	Skinner, in press
White fir / Douglas-fir	Oregon Caves NM, central Siskiyous, OR	*43*	not reported	low to moderate severity, fire size from 86-576 ha	1480 - 1989	composites of multiple trees, stand origin data	45 ha	Agee 1991
White fir	Oregon Caves NM, central Siskiyous, OR	*61 - 64*	not reported	low to moderate severity, fire size from 86-576 ha	1480 - 1989	composites of multiple trees, stand origin data	91 ha	Agee 1991

Area and vegetation	Location	Median or *mean* FRI [a]	Range of FRIs	Fire severity and extent	Period of record	Type of record	Size of sample area	Source
White fir / enriched mixed conifer	Western Marble Mtns., CA	*29*	not reported	mixed severity; most high severity in young even-aged stands and low severity in old-growth stands	not reported	composites of multiple trees	4 sites along mile-long transect	Thornburgh 1995
White fir	NF lands, across southwest OR	*~25* [b]	not reported	not reported	1380-1990	composites of stand origin and disturbance data	0.1 ha plots (296)	Atzet & Martin 1992
White fir	South Fork Mtn. and Bluff Creek, Six Rivers NF, CA	39	12 - 161	most fires of low to moderate severity, w/some high severity. No correlation between MFI and distance from ocean, elevation or latitude.	not reported	composites of multiple trees, across multiple sites	28 sites, 1.2 - 10.9 ha (mean = 4.2 ha)	Stuart & Salazar (in press [2000])
White fir	North-central Klamath Mtns., CA	*~25*	not reported	not reported	not reported	composites of multiple trees	25 km^2	Taylor & Skinner 1994
Upper Montane / Subalpine Zone								
Red fir	NF lands, across southwest OR	*~40* [b]	not reported	not reported	1580-1990	composites of stand origin and disturbance data	0.1 ha plots (40)	Atzet & Martin 1992
Mountain hemlock	NF lands, across southwest OR	*~115* [b]	not reported	not reported	1440-1990	composites of stand origin and disturbance data	0.1 ha plots (14)	Atzet & Martin 1992
Mountain hemlock	NF lands across southwest OR	12 - 36	not reported	Generally low fire severity. No relationship between aspect, slope, slope position or elevation with fire severity	1522 - 1998	stand origin and tree age data	0.1 ha plots	White et al. (in press)

Area and vegetation	Location	Median or *mean* FRI [a]	Range of FRIs	Fire severity and extent	Period of record	Type of record	Size of sample area	Source
Forests on Ultramafic Soils								
Jeffrey pine	NF lands across southwest OR	*~50* [b]	not reported	low severity	1540-1990	composites of stand origin and disturbance data	0.1 ha plots (31)	Atzet & Martin 1992
Jeffrey pine	NF lands across southwest OR	7 - 25	not reported	low to moderate severity. No relationship between aspect, slope, slope position or elevation with fire severity	1422 - 1998	stand origin and tree age data	0.1 ha plots	White et al. (in press)
California Coast Range								
Redwood	Bull Creek, Humboldt Redwoods State Park, CA	*5-16 (13-31)**	(8 - 87)	Mean fire size was 786 - 1097 ha, not correlated with fire frequency	1726 - 1940	composites of fire scars, basal sprouts and stand origin data	59 plots over 0.80 km^2 area	Stuart 1987
Redwood	Olema Valley, Pt. Reyes National Seashore, CA	*8 - 13*	4 - 17	low severity, w/variable fire size	1750 - 1998	composites of fire scars and stand origin data	not reported	Brown et al. 1999
Douglas-fir / redwood	Barnwell Creek, Interior Coast Range, CA	*12* (*11*)	4 - 22	mixed severity	1819 - 1950	composite of multiple trees	5 sample sites, no size reported	Rice 1990
Douglas-fir	Inverness Ridge, Pt. Reyes National Seashore, CA	*8 - 9*	1 - 18	low severity, w/ varaible fire size	1720 - 1998	composites of fire scars and stand origin data	not reported	Brown et al. 1999
Douglas-fir / hardwood	Elder Creek, Interior Coast Range, CA	*13* (*6*)	6 - 58	mixed severity, with ~50% high severity	1880 - 1983	composites of multiple trees	5 sites, size of area not reported	Rice 1990
Southern Cascades								
Ponderosa pine	Northeastern portion of	*17* (*4*)*	1 - 41	low severity	1501 - 1978	composites of	640 ha	Mastrogiuseppe 1999

	Crater Lake NP, OR					multiple trees		

Area and vegetation	Location	Median or *mean* FRI [a]	Range of FRIs	Fire severity and extent	Period of record	Type of record	Size of sample area	Source
Ponderosa pine	Southern Cascades, CA	16	8 - 32	low severity	not reported	composites of multiple trees	< 10 ha	Olson 1994
Jeffrey pine	Prospect Peak, Lassen Volcanic NP, CA	4 - 6*	1 - 29	low to moderate severity, median fire size of 200 ha (39-792 ha)	1656 - 1994	composites of multiple trees	742 ha	Taylor, in press [2000]
Douglas-fir / mixed conifer	Mill and Deer Creeks, CA	15*	2 - 56	increasing severity and decreasing frequency of fire from lower to upper slope positions	1800 - 1996	composites of multiple trees	11 sites, 0.25 to 3.0 ha each	Norman & Taylor, in press
Mixed conifer / white fir	Annie Creek, Crater Lake NP, OR	*17 (16)*	4 - 61	low severity, FRIs generally increase with elevation	1748 - 1902	composites of multiple trees	7.5 km^2	McNeil & Zobel 1980
Mixed conifer / white fir	Southern Cascades, CA	9 (10)	3 - 71 (3 - 71)	low severity	not reported	composites of multiple trees	< 10 ha	Olson 1994
Jeffrey pine / white fir	Prospect Peak, Lassen Volcanic NP, CA	5 - 10*	1 - 29	low to moderate severity, median fire size of 167 ha (6-666 ha)	1656 - 1994	composites of multiple trees	753 ha	Taylor, in press [2000]
Jeffrey pine / white fir	Southern Cascades, CA	12 (12)	4 - 157 (4 - 157)	not reported	not reported	composites of multiple trees	2 ha	Skinner unpublished data, reported in Skinner & Chang 1996
White fir / mixed conifer	Caribou Wilderness, CA	14*	not reported	mixed severity, with 13-33% high severity. Mean fire size ~ 128 ha	not reported	composites of multiple trees	506 ha	Taylor & Solem, in press (abstract)
White fir / mixed conifer	Southern Cascades, CA	10 (13)	3 - 24 (5 - 24)	not reported	not reported	composites of multiple trees	2 ha	Skinner, unpublished data, reported in Skinner & Chang 1996

Area and vegetation	**Location**	**Median or *mean* FRI [a]**	**Range of FRIs**	**Fire severity and extent**	**Period of record**	**Type of record**	**Size of sample area**	**Source**
White fir / mixed conifer	Southern Cascades, CA	9 (10)	3 - 26 (4 - 26)	not reported	not reported	composites of multiple trees	2 ha	Skinner, unpublished data, reported in Skinner & Chang 1996
White fir / mixed conifer	Thousand Lakes Wilderness, CA	4 - 9	not reported	> 50% high severity, most remainder moderate severity. Mean fire size 103-151 ha	not reported	composites of multiple trees	2042 ha	Bekker & Taylor, in press (abstract)
White fir	Southern Cascades, CA	9 (11)	4 - 56 (4 - 56)	not reported	not reported	composites of multiple trees	2 ha	Skinner unpublished data, reported in Skinner & Chang 1996
Red fir / western white pine	Prospect Peak, Lassen Volcanic NP, CA	9 - 27*	1 - 46	low to moderate severity, median fire size of 129 ha (11-733 ha)	1751 - 1994	composites of multiple trees	1135 ha	Taylor, in press [2000]
Red fir / mixed conifer	Caribou Wilderness, CA	29 - 35*		mean fire size ~128 ha	not reported	composites of multiple trees	506 ha	Taylor & Solem, in press (abstract)
Red fir	Swain Mountain, CA	*16 - 19**	1 - 57	low severity, mostly small fire size (13 – 400 ha)	1740 -1985	composites of multiple trees	3 ha plots and across 400 ha area	Taylor 1993
Red fir	Swain Mountain, CA	*40 - 42*	5 - 65	moderate severity	1830 -1985	stand origin data	2 plots, 1.0 and 0.48 ha	Taylor & Halpern 1991
Red fir / white fir	Annie Creek, Crater Lake NP, OR	*20* (*20*)	8 - 35 (8 - 35)	low to moderate severity, generally small fire size	1748 - 1902	composites of multiple trees	1 ha	McNeil & Zobel 1980
Red fir	Crater Peak, Crater Lake NP and adjacent NF land, OR	*45* (*39*)	15 - 157 (15 - 71)	mixed severity	1628 - 1988	composites of multiple trees	0.5 ha	Chappell & Agee 1996

Area and vegetation	Location	Median or *mean* FRI [a]	Range of FRIs	Fire severity and extent	Period of record	Type of record	Size of sample area	Source
Lodgepole pine / red fir	Caribou Wilderness, CA	24*	not reported	mixed severity, with ~50% high severity. Mean fire size larger than in red & white fir forest types.	not reported	composites of multiple trees	506 ha	Taylor & Solem, in press (abstract)
Lodgepole pine / red fir	Thousand Lakes Wilderness, CA	20 - 37	not reported	> 50% high fire severity, most of remainder moderate severity. Mean fire size 405 ha	not reported	composites of multiple trees	2042 ha	Bekker & Taylor, in press (abstract)

[a] Values in parentheses are specifically pre-1850 where available. Other values are for entire period of record. Italicized values are means, non-italicized values are medians.

[b] Estimates derived from total disturbance history of sampled stands and narrative section of plot data (see Atzet & Martin 1992 for details).

[c] Five distinct changes in fire occurrence were identified; 1490-1569, 1570-1844, 1845-1899, 1900-1925 and 1926-1996.

* Indicates statistically significant difference reported for return intervals between pre- (before 1850) and post-settlement periods.

1.9. TABLE 2. SUMMARY OF FIRE REGIME ATTRIBUTES FOR MAJOR FOREST ALLIANCES FOUND IN THE KLAMATH REGION OF NORTHWEST CALIFORNIA AND SOUTHWEST OREGON. This information is the product of a fire science workshop convened by the California Native Plant Society in Redding, CA, April 2000, and is based on the majority of professional opinion of workshop participants. Median fire return intervals and ranges of FRIs in italics are deviations from figures reported at workshop, based on fire history data collected from published and/or unpublished studies conducted in the Klamath Mountains.

Major Forest Alliances by Regional Setting **(e) = eastern subregion** (w) = western subregion	**TEMPORAL**			**SPATIAL**		**MAGNITUDE**		**TYPE**
	Median FRIs (yrs)	**Range of FRIs (yrs)**	**Months of fire occurrence**	**Fire size/extent**	**Fire complexity**	**Fire intensity**	**Fire Severity**	**Fire behavior**
Coastal / lowland Zone (0 to 2,000 feet)								
Coast redwood	*10 – 100 ?*	5 – 500+	July -October	Small up to thousands of hectares	Very high	low – high	low – high	Surface and passive crown fires
Western hemlock	*50 – 75*	10 – 200+	Aug – October	Small – intermediate, up to size of stand	High	low – high	moderate	Surface and passive crown fires
Foothill / lower montane Zone (500 to 4,000 feet)								
Oregon white oak (e)	1 – 5	1 – 25	July – October	Small up to size of stand	Low	Low	Low – moderate	Surface fires
California black oak	5 – 20	*1 – 40 ?*	May – October	Small up to size of stand	Low – Moderate	Low – moderate	Moderate – high	Surface fires
Canyon live oak	*10 – 30 ?*	5 – 100	May – October	Small up to hundreds of hectares	Low – moderate	low	Low	Surface fires
Knobcone pine	20 – 50	N/A	July - October	Small up to size of stand	Low	High – very high	High – very high	Surface to dependent crown fires
Foothill pine (e)	15 – 50	N/A	May – October	Small up to size of stand	Low – high	Low – very high	Low – high	Surface to passive crown fire
Douglas-fir/tanoak (w)	*10 – 30*	*5 – 150*	July – October	Small to tens of thousands of hectares	High	Low – very high	Low – very high	Surface to dependent crown fires
Douglas-fir/canyon live oak	10 – 35	*5 – 100 ?*	May – October	Small to hundreds of hectares	High	Low - moderate	Low – moderate	Surface – passive crown fires
Doug-fir/ponderosa pine (e)	10 – 20	*5 – 55*	June – October	Hundreds to tens of thousands of hectares	Low – moderate	Low – moderate	Low – moderate	Surface to dependent crown fires

Table 2, continued

Major Forest Alliances by Regional Setting **(e) = eastern subregion** (w) = western subregion	**TEMPORAL**			**SPATIAL**		**MAGNITUDE**		**TYPE**
	Median FRIs (yrs)	**Range of FRIs (yrs)**	**Months of fire occurrence**	**Fire size/extent**	**Fire complexity**	**Fire intensity**	**Fire Severity**	**Fire behavior**
Mid-montane Zone (3,000 to 6,000 feet)								
Douglas-fir/white fir (w)	*15 – 35*	*5 – 100*	August – October	Small to thousands of hectares	Moderate	Low – very high	Low – very high	Ground – independent crown fires
White fir	*25 – 65*	*10 – 160*	August – September	Small to hundreds of hectares	High	Low – high	Low – very high	Ground to independent crown fires
Upper Montane / Subalpine Zone (5,000 to 9,000 feet)								
Red fir	40 – 80	*5 – 150*	August – September	Small to thousands of hectares	High	Low – high	Low – very high	Surface to passive crown fires
Mountain hemlock	*100 – 125*	*50 – 300+*	August – September	Small up to size of stand	High	Low	Low – very high	Surface – passive crown fires
Whitebark/foxtail pine (e)	200+	N/A	August – September	Small, single trees or tree clumps	Low	Low – moderate	Low – moderate	Ground to surface fires
Subalpine mixed forest	200+	N/A	August – September	Small, single trees or tree clumps	Low	Low – moderate	Low – moderate	Ground to surface fires
Azonal Forest Types (all elevations)								
Jeffrey pine	40 – 80	*10 – 100 ?*	July – October	Small up to size of stand	High	Low – high	Low – high	Surface to passive crown fires
Port Orford-cedar	25 – 80	*10 – 200+*	August – October	Small up to size of stand	High	Low – high	Low – high	Surface to passive crown fires

2.0. SUMMARY OF FIRE REGIMES IN NON-FOREST VEGETATION

A. Chaparral

Chaparral dominates the lower elevations of Whiskeytown. This vegetation is a dense evergreen shrubland that is capable of tolerating more extreme summer drought than forest vegetation. Waring et al. (1978) have described the moisture stress beyond which conifer vegetation is intolerant. In the eastern Siskiyous, this commonly occurs on sites below 1,000 m. At Whiskeytown, more severe summer drought allows chaparral to extends to higher elevations. Considerable area at mid elevations of Whiskeytown, or relatively moist slope positions at lower elevations are characterized by a mixture of chaparral and oak and pine vegetation. Chaparral is also the early successional vegetation at higher elevations where conifer forest is the potential natural vegetation. In these circumstances, chaparral is generally replaced by conifer vegetation after 50-100 years in the absence of stand replacing disturbance. This variant is often referred to as montane chaparral

In southern California, it is well known that chaparral burns almost exclusively by crown fire. The fire ecology of chaparral In northern California and southern Oregon has been little studied in comparison. The research by Sampson (1944), who worked as far north as Shasta Co., suggests that, during wildfires, lower elevation chaparral, such as at Whiskeytown, would naturally burn primarily by crown fire. Montane chaparral at higher elevations may burn with mixed severity (Odion et al. in press), but stand-replacement is still common.

Chaparral plants do not provide a record of fire like some conifers. Thus, the historical frequency of fire in chaparral can only be inferred from other evidence. The frequency of fire in adjacent vegetation (Tables 1-2) can provide some inference, but uncertainty in estimates based on fire scar analysis are an issue. As described below, non-sprouting chaparral species, which are highly specialized to fire, are vulnerable to fire as frequent as estimated by many fire scar analyses (see section 2). These species are ubiquitous in chaparral in the Klamath region. This further suggests that fires in the past may have been less frequent than estimated by fire scar methods across much of the landscape.

<u>Management Concerns-</u> Over much of the range of chaparral, like many other shrublands worldwide, non-sprouting shrubs that are endemic to this vegetation are threatened by too frequent fire (Odion and Tyler 2002, Russell-Smith et al. 2002). This is because fire-free periods have shortened as a result of anthropogenic burning and invasion of exotic species that increase the combustibility of the shrublands when they are regenerating from fire. While fire is not presently too frequent in the Klamath region, it could become so locally where human ignitions increase and where extreme fire weather is common. This scenario could be realized in the vicinity of Whiskeytown.

Without sufficient time to replenish seed banks, non-sprouters can be eliminated by fire free periods that are short. In chaparral, annual grasses now often invade following fire, allowing for early reburns which have been found to replace the shrub vegetation with annual grassland as described below (Zedler et al. 1983). Research on a number of nonsrouting shrubs in chaparral has documented risk due to fire-free periods that are too short, but there is no evidence of a risk due to senescene in the absence of fire among species that have been studied (Zedler 1995, Keeley 2000, Odion and Tyler, 2002). The commonly accepted premise that chaparral becomes decadent with long fire-free periods has been shown to be generally false, and referred to as the "myth of stand senescence" in a recent review on chaparral (Keeley 2000), although forage available to deer may decrease if a greater proportion is beyond their reach. Moreover, fuel loading has been found not to be reliably predicted by stand age (Payson and Cohen 1990). Fire has been shown to burn readily through chaparral of any age class, at least if hot dry winds occur (Moritz et al. 2004). And, mature chaparral is resistant to invasion by exotic species. Considering these factors, Keeley (2002) pointed out that prescribed burning does not provide any resource benefit, is risky, and he recommended against it.

Another problem with prescribed burning in chaparral concerns the timing. Research has shown that moistening seed of chaparral plants that are not hard-seeded (i.e. species other than *Ceanothus* and most legumes) causes them to completely lose their heat tolerance (Sweeney 1956, Parker and Roger 1987). These seeds take up moisture seasonally, and as they dry out in summer, they become tolerant of high levels of heating. Seeds are likely to be especially vulnerable to burning after soils have been moistened in fall, but before fuel moisture has risen appreciably, because considerable heat could still be generated by fire at this time. Thus, burning under these conditions is likely to produce unnaturally high seed mortality and result in artificially low seedling emergence (Parker and Roger 1988). This would have adverse, long-term impacts in stands lacking resprouting species. On the other hand, if soils are really wet at the time of fire, and fireline intensity is relatively low, little soil heating will occur (DeBano et al. 1979). In this situation, hard-seeded species may not receive sufficient heat shock to germinate, resulting in a similar impact scenario. It is unclear which other species would be cued to germinate. Thus, out of season burning in areas dominated by non-sprouting shrubs (*Arctostaphylos viscida, Ceanothus integerrimus, Ceanothus cuneatu*s, and in conifer forests, *C. velutinus* and *C. prostratus*), may have poor regeneration of shrubs and other fire-recruiting species. Populations of species with fire-dependent recruitment (in the absence of soil disturbance) will be reduced as a result, and seed banks will be depleted. Thus, out of season burning can also reduce fire annuals and short-lived fire followers because their seed may not be present to germinate following the next fire at the site, and it does not disperse in from surrounding areas. These species are not likely to be resilient to these effects. Another factor that can contribute to reduced post-burn shrub recruitment is spring burning followed by rainfall sufficient to induce germination of surviving seeds. Seedlings that establish from such late germination have been found to have greater mortality during their initial summer (Moreno and Oechel 1993).

Burned areas of poor shrub regeneration will be more prone to invasion by yellow starthistle, cheatgrass and other annual grasses. The fine fuel of these annual grasses can carry fire and allow for a reburn before shrubs have begun to produce seeds. Also, mortality of young resprouts can occur, and shrubs are often too depleted to resprout again. Thus, such successive, short rotation (< 5 years apart) fires can largely eliminate chaparral (Zedler et al. 1983). The shallow-rooted and quickly curing grass and weed vegetation that replaces chaparral under such type conversion will ignite more easily over a longer portion of the year, spread fire more rapidly, make slopes vulnerable to a future regime of more frequent fire and disturbances related to reduced slope stability in the absence of deep rooted shrubs.

B. Great Basin Shrublands

Sagebrush, juniper, and rosaceous shrubland dominate much of the landscape at Lava beds. Rosaceous shrubland is composed of deciduous species with relatively soft leaves lacking obvious drought adaptation of chaparral sclerophylls. The Rosaceous shrubland also appears to differ by not being a crown-fire dependent vegetation like chaparral. Sampson (1944) did report a 4 times increase in germination rates for western chokecherry (*Prunus virginiana*) when seeds were heated to ~105^{o}C, but germination also occurred without fire effects. Most of the dominants of the rosaceous shrubland are found throughout the Great Basin in an association sometimes referred to as petran chaparral. The dense nature of the shrubs/small trees, with interlocking crowns, resembles typical chaparral architecturally, but in other respects this is functionally different vegetation. Rosaceous shrubland at Mesa Verde National Park, a rocky environment, is believed to burn very infrequently (~400 years) despite a particularly high frequency of lightning (Romme et al. 2003).

In sagebrush and juniper vegetation, the junipers are, in places, increasing in density and expanding into adjoining sagebrush shrublands and grasslands. This is believed to be caused by fire exclusion, livestock grazing, and climate change. Baker and Shinneman (2004) systematically reviewed the literature for available evidence to help determine which factor is most important or how each factor has contributed to change. While fire, is believed by many to have been frequent enough, prior to fire suppression, to have maintained low-density pinyon–juniper savannas and woodlands in some areas and to have prevented tree invasion into sagebrush and grasslands evidence of low-severity surface fire is lacking because the trees do not reliably record fire scars. Conversely, there is evidence that fire regimes in sagebrush and juniper vegetation in many areas consisted of mixed and high-severity fires and that these fires, though perhaps infrequent, structured the vegetation. There is also evidence that climate fluctuations have favored juniper expansion (Soule et al. 2004). In eastern Oregon, Soule et al. studied juniper establishment in disturbed and undisturbed areas and concluded that
The driving forces explaining the late 1800s to early 1900s pulse of establishment for western juniper are livestock grazing and favorable climatic conditions, while absence of crown fire has allowed disturbance facilitated cohorts to persist.

<u>Management Concerns-</u> There is concern about juniper expansion into sagebrush at Lava Beds. However, imprecise knowledge of past vegetation structure, and fluctuation in juniper abundance with infrequent high severity fire along with climate change makes identification of appropriate and realistic restoration targets difficult. In addition, mechanical removal of trees may have detrimental impacts to wildlife and other resources. Baker and Shinneman conclude that “local research is essential, at the present time, if effective, scientifically based restoration prescriptions are to be derived.”

C. Bald Hills Vegetation

Bald hill grassland and oak vegetation occurs on hilltops in Redwood National Park. This vegetation has been studied by Sugihara et al. (1987). It is estimated that Native Americans regularly set fire to these bald hills for 6,000 years. Frequent burning can prevent the establishment of woody plants. Following the demise of Native Americans, fire has largely been absent from the bald hills. In addition, the bald hills have been grazed by livestock and invaded by exotic grasses. Successional changes in the absence of fire and grazing in the bald hills takes two forms. In relatively xeric interior areas, succession is from grassland and oak savanna to mixed evergreen forest that includes tanoak and Douglas-fir. In more coastal and mesic areas redwood forest with Douglas-fir may replace open oak and grassland vegetation.

Management Concerns- It is not clear what the frequency of fire and the vegetation would have been in the past without native American impacts, nor to what extent climate change may be influencing current dynamics toward more woody vegetation.

2.1. LITERATURE CITED AND BIBLIOGRAPHY OF RELEVENT STUDIES

Abbott, L.L. 1987. The effect of fire on subsequent growth of surviving trees in an old-growth redwood forest in Redwood National Park, CA. Thesis, Humboldt State University, Arcata, CA..

Aber, J., N. Christensen, I. Fernandez, J. Franklin, L. Hidinger, M. Hunter, J. MacMahon, D. Mladenoff, J. Pastor, D. Perry, R. Slangen and H. van Miegroet. 2000. Applying ecological principles to management of the U.S. National Forests. Issues in Ecology. No. 6. Ecological Society of America, Washington, D.C.

Adams, S. and J.O. Sawyer, Jr. No date. Past fire incidence in mixed evergreen forests of northwest California. Unpublished report, Six Rivers National Forest, Eureka, CA.

Agee, J. K. 1993. Fire Ecology of Pacific Northwest Forests. Island Press, Covelo, California.

Agee, J.K. 1981. Fire effects on Pacific Northwest forests: Flora, fuels, and fauna. Pp. 54-66 in: Northwest Forest Fire Council Proceedings, Northwest Forest Fire Council, Portland, OR.

Agee, J.K. 1990. The historical role of fire in Pacific Northwest forests. Pp. 25-38 in: J.D. Walstad, S.R. Radosevich and D.V. Sandberg, eds. Natural and prescribed fire in the Pacific Northwest. Oregon State University Press, Corvallis, OR.

Agee, J.K. 1991a. Fire history along an elevational gradient in the Siskiyou Mountains, Oregon. Northwest Science 65: 188-199.

Agee, J.K. 1991b. Fire history of Douglas-fir forests in the Pacific Northwest. Pp. 25-33 in: L.F. Ruggiero *et al.*, eds. Wildlife and vegetation of unmanaged Douglas-fir forests. USDA Forest Service, Pacific Northwest Research Station, Gen. Tech. Report PNW-GTR-285. Agee, J.K. 1993. Fire Ecology of Pacific Northwest Forests. Island Press, Washington, D.C.

Agee, J.K. 1994. Fire and weather disturbances in terrestrial ecosystems of the eastern Cascades. USDA Forest Service Pacific Northwest Research Station Gen. Tech. Report PNW-GTR-320. Portland, OR.

Agee, J.K. 1996a. The influence of forest structure on fire behavior. In: Proceedings –Seventeenth Annual Forest Vegetation Management Conference, January 16-18, 1996, Redding, CA.

Agee, J.K. 1996b. Fire restoration in Oregon white oak woodlands. Pp. 72-73 in: C.C. Hardy and S.F. Arno, eds. The use of fire in forest restoration. USDA Forest Service Intermountain Research Station, Gen. Tech. Rep. INT-GTR-341. Ogden, UT.

Agee, J.K. 1997. Severe fire weather – too hot to handle? Northwest Science 71(1): 153-156.

Agee, J.K. 1998. The landscape ecology of western forest fire regimes. Northwest Science 72 (special issue): 24-34.

Agee, J.K. and L. Smith 1984. Subalpine tree establishment after fire in the Olympic Mountains, Washington. Ecology 65: 810-819.

Agee, J.K. and M.H. Huff. 1986. Structure and process goals for vegetation in wilderness areas.

Agee, J.K. and R. Flewelling. 1983. A fire cycle model based on climate for the Olympic Mountains, Washington. Fire and Forest Meteorology Conference 7: 32-37.

Agee, J.K. and R.L. Edmonds. 1992. Forest protection guidelines for the northern spotted owl. In: Final draft recovery plan for the northern spotted owl. Appendix E. U.S. Department of Interior, Washington, D.C.

Agee, J.K., B. Bahro, M.A. Finney, P.N. Omi, D.B. Sapsis, C.N. Skinner, J.W. van Wagtendonk and C.P. Weatherspoon. 1999. The use of shaded fuelbreaks in landscape fire management. Forest Ecology and Management 48(1): 1-12.

Agee, J.K., L. Potash and M. Gracz. 1990. Oregon Caves forest and fire history. National Park Service Report CPSU/UW 90-1, Cooperative Park Studies Unit, College of Forest Resources, University of Washington, Seattle, WA.

Allen, C. D., M. Savage, D. A. Falk, K. F. Suckling, T. W. Swetnam, T. Schulke, P. B. Stacey P. Morgan, M. Hoffman, J. T. Klingel. 2002. Ecological restoration of southwestern ponderosa pine ecosystems: a broad perspective. Ecological Applications 12: 1418–1433.

Anderson, M.K. and M. Moratto. 1996. Native American land use practices and ecological impacts. Pp. 187-206 in: Status of the Sierra Nevada: Sierra Nevada Ecosystem Project Final Report to Congress Volume II. Wildland Resources Center Report No. 37. Center for Water and Wildland Resources. University of California, Davis.

Arno, M.K. 1996. Reestablishing fire-adapted communities to riparian forests in the ponderosa pine zone. Pp. 42-44 in: Hardy, C.C. and S.F. Arno, eds. The use of fire in forest restoration. USDA Forest Service Intermountain Research Station Gen. Tech. Report INT-GTR-341. Ogden, UT.

Arno, S.F. and K.M. Sneck. 1977. A method for determining fire history in coniferous forests of the Mountain West. USDA Forest Service Intermountain Research Station Gen. Tech. Report INT-GTR-42. Ogden, UT.

Arno, S.F., M.G. Harrington, C.E. Fiedler and C.E. Carlson. 1995. Restoring fire-dependent ponderosa pine forests in western Montana. Restoration and Management Notes 13(1): 32-36.

Attiwill, P.M. 1994. The disturbance of forest ecosystems: The ecological basis for conservation management. Forest Ecology and Management 63: 247-300.

Atzet, T. 1996. Fire regimes and restoration needs in southwestern Oregon. Pp. 74-76 in: C.C. Hardy and S.F. Arno, eds. The use of fire in forest restoration. USDA Forest Service Intermountain Research Station, Gen. Tech. Rep. INT-GTR-341. Ogden, UT.

Atzet, T. and D.L. Wheeler. 1982. Historical and ecological perspectives on fire activity in the Klamath Geological Province of the Rogue River and Siskiyou National Forests. USDA Forest Service, Pacific Northwest Region, Publication R6-Range-102. Portland, OR.

Atzet, T. and R. Martin. 1992. Natural disturbance regimes in the Klamath Province. Pp. 40-48 in: Kerner, H.M. ed. Proceedings of the Symposium on Biodiversity of Northwestern California, Oct. 28-30, 1991, Santa Rosa, CA. Wildland Resources Center Report 29, Berkeley, CA.

Atzet, T., D.E. White, L.A. McCrimmon, P.A. Martinez, P.R. Fong and V.D. Randall. 1996. A field guide to the forested plant associations of southwestern Oregon. USDA Forest Service Technical Paper R6-NR-ECOL-TP-17-96. Grants Pass, OR.

Atzet, T., D.L. Wheeler and R. Gripp. 1988. Fire and forestry in southwest Oregon. FIR report 9(4): 4-7.

Atzet, T., D.L. Wheeler, B. Smith, J. Franklin, G. Riegel and D. Thornburgh. 1992. Vegetation. Pp. 92-113 in: S.D. Hobbs, ed. Reforestation practices in southwestern Oregon and northern California. Forest Research Laboratory, Oregon State University, Corvallis, OR.

Automated Lightning Detection System, April 1995 – November 1997. In: Program for climate, ecosystem, and fire application. Desert Research Institute and USDI Bureau of Land Management, Reno, NV. Available at http://www.dri.edu/Programs/CEFA/Cefa_Products/cefaprod_index.htm

Baker, W. L. 1992. Effects of settlement and fire suppression on landscape structure. Ecology 73: 1879–1887.

Baker, W. L. and D. Shinneman. 2004. Fire and restoration of pin˜on–juniper woodlands in the western United States: a review. Forest Ecology and Mangement 189: 1-21.

Baker, W.L. 1993. Spatially heterogeneous multi-scale response of landscapes to fire suppression. Oikos 66: 66-71.

Baker, W.L. 1994. Restoration of landscape structure altered by fire suppression. Conservation Biology 8(3): 763-769.

Baker, W.L., and D. Ehle. 2001. Uncertainty in surface-fire history: the case of ponderosa pine forests in the western United States. Canadian Journal of Forest Research 31: 1205-1226.

Barbour, M.G. and R.A. Minnich. 1999. California upland forests and woodlands. Pp. 161-201 in: M.G. Barbour and W.D. Billings, eds. North American terrestrial vegetation, second edition. Cambridge University Press, New York, NY.

Barrett, S.W. and S.F. Arno. 1982. Indian fires as an ecological influence in the northern Rockies. Journal of Forestry 80(10): 647-650.

Bekker, M.F. and A.H. Taylor. In press. Gradient analysis of fire regimes in montane forests of the Thousand Lakes Wilderness, Southern Cascades Range, California USA.

Bingham, B. B. and J. O. Sawyer. 1992. Canopy status and tree condition of young, mature and old-growth Douglas-fir/hardwood forests. Pages 141-149 in R. R. Harris, D. E. Erman and H. M. Kerner, editors. Biodiversity of Northwestern California. Wildland Resource Center Report No. 29. University of California, Berkeley, CA. USA.

Bingham, B.B. and J.O. Sawyer. 1992. Canopy status and tree condition of young, mature and old-growth Douglas-fir/hardwood forests. Pp. 141-149 in R.R. Harris, D.E. Erman and H.M. Kerner, eds. Biodiversity of northwestern California. Wildland Resource Center Report No. 29. University of California, Berkeley, CA.

Biswell, H.H. 1989. Prescribed Burning in California Wildlands Vegetation Management. University of California Press, Berkeley, CA.

Bond, W.J. and B.W. van Wilgen. 1996. Fire and Plants. Chapman and Hall, London, U.K.

Bonnicksen, T. M. and E. C. Stone. 1985. Restoring naturalness to national parks. Environmental Management 9: 479-486.

Bonnicksen, T.M. and E.C. Stone. 1981. The giant sequoia-mixed conifer forest community characterized through pattern analysis as a mosaic of aggregations. Forest Ecology and Management 3: 307-328.

Borchert, M. I. and D. C. Odion. 1995. Fire intensity and vegetation recovery in chaparral: a review. Pages 91-100 in Brushfires in California Wildlands: Ecology and resource management. International Association of Wildland Fire, Fairfield, WA.

Bossard, C.C., J. M. Randall, and M. C. Hoschovsky (eds.) 2000. Invasive plants of California's wildlands. University of California Press, Berkeley, Ca.

Boyd, R.J. 1986. Strategies of Indian burning in the Willamette Valley. Canadian Journal of Anthropology 5: 65-86.

Bradstock, R. A., and A. M. Gill. 2001. Living with fire and biodiversity at the urban edge: in search of sustainable solutions to the human protection problem in Southern Australia. Journal of Mediterranean Ecology 2: 179-195.

Brookes, M.H., editor. 1996. Disturbance and forest health in Oregon and Washington. USDA Forest Service Pacific Northwest Research Station Gen. Tech. Report PNW-GTR-381. Portland, OR.

Brown, C.E. 1960. History of the Rogue River National Forest, Volume 1: 1893-1932. Unpublished report on file with Rogue River National Forest, Medford, OR.

Brown, J. K.; and J. K. Smith (eds.) 2000. Wildland fire in ecosystems: effects of fire on flora. Gen. Tech. Rep. RMRS-GTR-42-vol. 2. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 257 p.

Brown, J.K. 1994. Fire regimes and their relevance to ecosystem management. A paper presented at the 1994 Society of American Foresters Canadian Institute of Forestry Convention, September 18-22, 1993, Anchorage, AK.

Brown, P.M. 1991. Dendrochronology and fire history in a stand of northern California coast redwood. Master's Thesis, School of Renewable Natural Resources, University of Arizona. Phoenix, AZ.

Brown, P.M. and T.W. Swetnam. 1994. A cross-dated fire history from coast redwood near Redwood National Park, California. Canadian Journal of Forest Research 24: 21-31.

Brown, P.M., M.W. Kaye and D. Buckley. 1999. Fire history in Douglas-fir and coast redwood forests at Point Reyes National Seashore, California. Northwest Science 73(3): 205-216.

Bunting, S.C. 1996. The use and role of fire in natural areas. Pp. 277-301 in: R.G. Wright, ed. National parks and protected areas: Their role in environmental protection. Blackwell Science. Cambridge, MA.

Burke, C.J. 1979. Historic fires in the central western Cascades, Oregon. Master's thesis, Oregon State University, Corvallis, OR.

Burns, F. 1911. The Crater National Forest: Its resources and their conservation. USDA Forest Service Bulletin 100. Washington, D.C.

Byram, G. M. 1959. Combustion of forest fuels. Pages 61-89 in K. P. Davis editor. Forest Fire; Control and Use. McGraw-Hill, New York.

California Department of Forestry (CDF). 1999. Fire history – database background and description. Available online at: http://frap.cdf.ca.gov/data/fire_data/history/fire_history_background.html

Caprio, A. C. and P. Lineback. In Press. Pre-Twentieth Century Fire History of Sequoia and Kings Canyon National Park: A Review and Evaluation of Our Knowledge. Presented at the 1997 Symposioum on Fire in California Ecosystems: Integrating Ecology, Prevention, and Management, 1997, San Diego, CA. International Association of Wildland Fire, Fairfield, WA. http://www.ice.ucdavis.edu/cafe/agenda97/FireEcology/History/8FECaprio.html.

Caprio, A.C. and T.W. Swetnam. 1995. Historic fire regimes along an elevational gradient on the west slope of the Sierra Nevada, California. In: J.K. Brown, R.W. Mutch, C.W. Spoon, R.H. Wakimoto (tech. coord.). Proceedings: Symposium on Fire in Wilderness and Park Management: Past Lessons and Future Opportunities, March 30-April 1, 1993, Missoula Montana. USDA Forest Service, INT-GTR-320.

Caprio, A.C., and T.W. Swetnam. 1994. Fire history and fire climatology in the southern and central Sierra Nevada: Progress Report 1993/94 to National Park Service, Global Change Program, Southern and Central Sierra Nevada Biogeographical Area. Laboratory of Tree-Ring Research, University of Arizona, Tucson, AZ. On file at Sequoia and Kings Canyon National Park. 16 pp.

Cary, H. and M. Schumann. 2003. Modifying wildfire behavior—the effectiveness of fuel treatments. Southwest Region Working paper 2. National Community Forestry Center: Santa Fe, NM.

Cerney, M. 1998. Analysis of fuel and stand density reduction following prescribed fire in a ponderosa pine stand in California's Lassen National Forest. Thesis, Humboldt State University, Arcata, CA.

Chang, C.R. 1996. Ecosystem responses to fire and variations in fire regimes. Pp. 1071-1099 in: Status of the Sierra Nevada: Sierra Nevada Ecosystem Project Final Report to Congress Volume II. Wildland Resources Center Report No. 37. Center for Water and Wildland Resources. University of California, Davis.

Chappell, C.B. 1991. Fire ecology and seedling establishment in Shasta red fir (*Abies magnifica* var. *shastensis*) forests of Crater Lake National Park, Oregon. Thesis, University of Washington, Seattle, WA.

Chappell, C.B. and J.K. Agee. 1996. Fire severity and tree seedling establishment in *Abies magnifica* forests, southern Cascades, Oregon. Ecological Applications 6(2): 628-640.

Christensen, N. L. 1991. Wilderness and high intensity fire: how much is enough. Pages 9-24 in Proceedings of the 17th Tall Timbers Fire Ecology Conference, May, 1989, Tallahassee, Florida.

Christensen, N.L. 1985. Shrubland fire regimes and their evolutionary consequences. In: S.T.A. Pickett and P. White, eds. The ecology of natural disturbance and patch dynamics. Pp. 85-100. Academic Press, New York, NY.

Christensen, N.L. 1991. Variable fire regimes on complex landscapes: Ecological consequences, policy implications and management strategies. In: Fire and the environment: Ecological and cultural perspectives. Proc. of an International Symposium, Knoxville, TN, March 22-24, 1990. USDA Forest Service Southeastern Research Station Gen. Tech. Report SE-69.

Christensen, N.L. 1993. Fire regimes and ecosystem dynamics. Pp. 233-244 in: Crutzen, P.J., and J.G. Goldhammer, eds. Fire in the environment: The ecological, atmospherical and climatic importance of vegetation fires. Wiley & Sons, New York, NY.

Cissel, J.H. and others. 1998. A landscape plan based on historical fire regimes for a managed forest ecosystem: the Augusta Creek study. USDA Forest Service Pacific Northwest Research Station Gen. Tech. Report PNW-GTR-422. Portland, OR.

Cissel, J.H., F.J. Swanson and P.J. Weisberg. 1999. Landscape management using historical fire regimes: Blue River, Oregon. Ecological Applications 9(4): 1217-1231.

Cohen, J.D. 2000. Preventing disaster: home ignitability in the Wildland-Urban Interface. Journal of Forestry 98:15-21.

Coleman, R.G. and A.R. Kruckeberg. 1999. Geology and plant life of the Klamath-Siskiyou Mountain region. Natural Areas Journal 19(4): 320-340.

Connell, J.H. 1978. Diversity in Tropical Forests and Coral Reefs. *Science* 199: 1302-1309.

Cooper, D.W. 1965. The coast redwood and its ecology. Humboldt County Agricultural Extension Service, Eureka, CA.

Cooper, R.L. 1939. History of the Siskiyou National Forest. Unpublished report on file with the Siskiyou National Forest, Grants Pass, OR.

Countryman, C. M. 1955. Old-growth conversion also converts fire climate. U.S. Forest Service Fire Control Notes 17: 15-19.

Covington, W.W. and M.M. Moore. 1994. Southwestern ponderosa pine forest structure: Changes since Euro-American settlement. Journal of Forestry 92: 39-47.

Covington, W.W. and P.K. Wagner, eds. 1996. Conference on adaptive ecosystem restoration and management: Restoration of Cordilleran conifer landscapes of North America. June 6-8, 1996, Flagstaff, AZ. USDA Forest Service Rocky Mountain Research Station Gen. Tech. Report RM-GTR-278. Fort Collins, CO.

Davies, G.W. and F.M. Frank, eds. 1992. Stories of the Klamath National Forest, the first 50 years: 1905-1955. History Ink Books, Hat Creek, CA.

DeBano, L. F., R. M. Rice, and C. E. Conrad. 1979. Soil heating in chaparral fires: effects on soil properties, plant nutrients, erosion and runoff. USDA Forest Service Research Paper PSW-145.

Delcourt, H.R. and P.A. Delcourt. 1997. Pre-Columbian native American use of fire on southern Appalachian landscapes. Conservation Biology 11: 1010-1014.

DellaSala, D. A., and E. J. Frost. 2001. An ecologically based strategy for fire and fuels management in national forest roadless areas. Fire Management Today 61: 12-23.

DellaSala, D. A., S. B. Reid, T. J. Frest, J. R. Strittholt and D. M. Olson. 1999. A global perspective on the biodiversity of the Klamath-Siskiyou Ecoregion. Natural Areas Journal 19:300-319.

DellaSala, D.A. 2004. State of the Klamath Knot: how far have we come and where are we going. Proceedings of Siskiyou Conference xxx.

DellaSala, D.A. and E.J. Frost. 2001. An ecologically-based strategy for fire and fuels management in national forest roadless areas. Fire Management Today.

DeLong, S.C. 1998. Disturbance rate and patch size distribution of forests in northern British Columbia: Implications for forest management. Northwest Science 72 (special issue): 35-48.

Detling, L.E. 1961. The chaparral formation of southwestern Oregon, with considerations of its post-glacial history. Ecology 42: 348-357.

Dickman, A. and S. Cook. 1989. Fire and fungus in a mountain hemlock forest. Canadian Journal of Botany 67: 2005-2016.

Dieterich, J.H. and T.W. Swetnam. 1984. Dendrochronology of a fire-scarred ponderosa pine. Forest Science 30: 238-247.

Duebendorfer, T.E. 1987. Vegetation-soil relations on ultramafic parent material, Pine Flat Mountain, Del Norte County, California. Master's thesis, Humboldt State University, Arcata, CA.

Ecosystem Project, Final Report to Congress Volume I, Assessment summaries and management strategies. Wildland Resources Center Report No. 37. Center for Water and Wildland Resources. University of California, Davis, CA.

Ehle, D. S., and W. L. Baker. 2004. Disturbance and stand dynamics in ponderosa pine forests in Rocky Mountain National Park, USA. Ecological Monographs: in press 73(4).

Erman, D.C. and R. Jones. 1996. Fire frequency analysis of Sierra forests. Pp. 1139-1146 in: Status of the Sierra Nevada: Sierra Nevada Ecosystem Project Final Report to Congress Volume II. Wildland Resources Center Report No. 37. Center for Water and Wildland Resources. University of California, Davis.

Everett, R.L., D. Schellhaus, D. Spurbeck, P. Ohlson, D. Keenum and T. Anderson. 1997. Structure of northern spotted owl nest stands and their historical conditions on the eastern slope of the Pacific Northwest Cascades, USA. Forest Ecology and Management 94: 1-14.

Everett, R.L., P.F. Hessburg, M. Jensen and B. Bormann. 1994. Eastside forest ecosystem health assessment. Volume I. Executive Summary. USDA Forest Service, Pacific Northwest Research Station General Technical Report PNW-GTR-317. Portland, OR.

Everett, R.L., R. Schellhaus, D. Keenum, D. Spurbeck and P. Ohlson. 2000. Fire history in the ponderosa pine/Douglas-fir forests on the east slope of the Washington Cascades. Forest Ecology and Management 129: 207-225.

Eyre, F.H., ed. Forest cover types of the United States and Canada. Society of American Foresters, Washington, D.C.

Filip, G.M., L.D. Bryant and C.A. Parks. 1989. Mass movement of river ice causes severe tree wounds along the Grand Ronde River in northeastern Oregon. Northwest Science 63: 211-213.

Finney, M.A. 1991. Ecological effects of prescribed and simulated fire on the coast redwood (*Sequoia sempervirens*). Dissertation, University of California, Berkeley, CA

Finney, M.A. and R.E. Martin. 1989. Fire history in a *Sequoia sempervirens* forest at Salt Point State Park, California. Canadian Journal of Forest Research 19: 1451-1457.

Finney, M.A. and R.E. Martin. 1992. Short fire intervals recorded at Annadale State Park, California. Madrono 39: 251-262.

Fites, J. 1993. Ecological guide to mixed conifer plant associations. R5-ECOL-TP-001. USDA Forest Service Pacific Southwest Region, San Francisco, CA.

Fites-Kaufman, J. 1997. Historic landscape pattern and process: Fire, vegetation, and environment interactions in the northern Sierra Nevada. Ph.D. dissertation, University of Washington, Seattle, WA.

Forest Ecosystem Management Assessment Team (FEMAT). 1993. Forest Ecosystem Management: An ecological, economic, and social assessment. Report of the Forest Ecosystem Management Assessment Team. July 1993. Portland, OR.

Forest Service Employees for Environmental Ethics (FSEEE). 1999. Restoring our forest legacy: Blueprint for Sierra Nevada National Forests. Forest Service Employees for Environmental Ethics, Eugene, OR.

Franklin, J.F. and C.T. Dyrness. 1973. Natural vegetation of Oregon and Washington. USDA Forest Service Pacific Northwest Research Station Gen. Tech. Report PNW-8. Portland, OR.

Fritz, E. 1931. The role of fire in the redwood region. Journal of Forestry 29: 939-950.

Frost, E. J. and D. C. Odion. 2002. Fire as an object of scientific interest and implications for forest management, Pages 76-91 in D.C. Odion and E.J. Frost, eds. Protecting Objects of Scientific Interest in the Cascade-Siskiyou National Monument: Status, Threats and Management Recommendations. Published by the World Wildlife Fund, Klamath-Siskiyou Regional Program, Ashland, OR. http://www.worldwildlife.org/klamathsiskiyou/objects_interest2.pdf

Frost, E. J. and R. Sweeney. 2000. Fire regimes, fire history, and forest conditions in the Klamath-Siskiyou region: an overview and synthesis of knowledge. Report prepared for World Wildlif e Fund. url: **http://www.worldwildlife.org/forests/attachments/fire_report.pdf**

Frost, E.J. 1999. The scientific basis for managing fire and fuels in national forest roadless areas. Unpublished report prepared for the World Wildlife Fund - US, Klamath-Siskiyou Ecoregion Program, Ashland, OR.

Fule, P.Z., W.W. Covington and M.M. Moore. 1997. Determining reference conditions for ecosystem management of southwestern ponderosa pine. Ecological Applications 7: 895-908.

Graetz, D.H. 1999. Integrating GIS and heuristic modeling to achieve resource management goals in the Applegate River watershed, southwestern Oregon. In: Proceedings, 1999 Society of American Foresters annual convention, Bethesda, MD.

Gripp, R.A. 1976. An appraisal of critical fire weather in northwestern California. Thesis, Humboldt State University, Arcata, CA.

Habeck, J.R. 1961. The original vegetation of the mid-Willamette Valley, Oregon. Northwest Science 35: 65-77.

Halpern, C. B., Spies, T. A. 1995: Plant Species Diversity in Natural and Managed Forests of the Pacific Northwest. Ecological Applications 5: 913–934.

Hann, W.J. *et al.* 1997. Landscape dynamics of the Basin. Pp. 337-1,055 in: Quigley, T.M. and S.J. Arbelbide (eds.). An assessment of ecosystem components in the Interior Columbia Basin and portions of the Klamath and Great Basins: Volume II. USDA Forest Service Pacific Northwest Research Station Gen. Tech. Rep. PNW-GTR-405. Portland, OR.

Hardy, C.C. 1983. An evaluation of alternative fuel treatments on the Siskiyou National Forest, southwest Oregon. Master of Forest Resources Prof. Paper, University of Washington, Seattle, WA. 110 pp.

Hardy, C.C. and S.F. Arno, eds. 1996. The use of fire in forest restoration. USDA Forest Service Intermountain Research Station Gen. Tech. Report INT-GTR-341. Ogden, UT.

Hardy, C.C., D.L. Bunnell, J.P. Menakis, K.M. Schmidt, D.G. Long, D.G. Simmerman and C.M. Johnston. 1999. Coarse-scale spatial data for wildland fire and fuel management. USDA Forest Service Rocky Mountain Research Station, Fire Sciences Laboratory, Missoula, MT. Available online at: <http://www.fs.fed.us/fire/fuelman>.

Hardy, C.C., R.E. Keane and M.G. Harrington. 1999. Restoration in Northwest interior forests. Transactions 64th North American Wildlife And Natural Resources Conference: 117-137.

Harrington, M. G. Ponderosa pine mortality for spring, summer and fall crown scorching. Western Journal of Applied Forestry 2: 14-16.

Hayes, G.L. 1959. Forest and forest-land problems of southwestern Oregon. USDA Forest Service, Pacific Northwest Forest and Range Experiment Station Research Paper PNW-58. Portland, OR.

Helgerson, O. 1988. Historic fire year for Oregon and California. Oregon State University FIR report 9(4): 2-4.

Heyerdahl, E.K., L.B. Brubaker and J.K. Agee. 2001. Factors controlling spatial variation in historical fire regimes: A multi-scale example from the interior West, USA. Ecology 82: 660-678.

Hof, J. and P. N. Omi. 2003. Scheduling removals for fuels management. Pages 367-378 in P. N. Omi and L. A. Joyce, technical eds. Fire, Fuel treatments and Ecological Restoration: Conference Proceedings. USDA Forest Service RMRS-P-29. Rocky Mountain Research Station, Fort Collins, Co.

Hofmann, J.V. 1917. The relation of brush fires to natural reproduction: Applegate Division of the Crater National Forest. Wind River, WA: USDA Forest Service, Wind River Experiment Station.

Huff, M.H. and J.K. Agee. 1991. Subalpine forest dynamics after fire in the Pacific Northwest national parks. National Park Service Cooperative Studies Unit, College of Forest Resources, University of Washington, Seattle, WA.

Huff, M.H., R.D. Ottmar, E. Alvarado, R.E. Vihnanek, J.F. Lehmkuhl, P.F. Hessburg, and R.L. Everett. 1995. Historical and current landscapes in eastern Oregon and Washington. Part II: Linking vegetation characteristics to potential fire behavior and related smoke production. USDA Forest Service Pacific Northwest Forest and Range Experiment Station, PNW-GTR- 355. Portland, Oregon.

Hunter, J.C. 1997. Fourteen years of change in two old-growth *Pseudotsuga-Lithocarpus* forests in northern California. Journal of the Torrey Botanical Society 124(4): 273-279.

Hunter, M. L. (editor). 1999. Maintaining Biodiversity in Forest Ecosystems. Cambridge University Press, Cambridge, U.K.

Hunter, M.L. 1991. Coping with ignorance: The coarse-filter strategy for maintaining biodiversity. Pages 261-281 in: K.A. Kohm, ed. Balancing on the brink of extinction: The Endangered Species Act and lessons for the future. Island Press, Washington, D.C.

Husari, S.J. 1980. Fire ecology of the vegetative habitat types in the Lassen Fire Management Planning Area (Caribou Wilderness and Lassen Volcanic National Park). In: Fire management plan: Lassen Fire Management Planning Area, Caribou Unit. Lassen Volcanic National Park and Lassen National Forest. Susanville, CA.

Husari, S.J. and K.S. Hawk. 1994. The role of past and present disturbance in California ecosystems. In: Manley, P.N., P. Aune, C. Cook, M.E. Flores, D.G. Fullmer, S.J. Husari, T.M. Jimerson, M.E. McCain, G. Schmitt, J. Schuyler, W. Bertrand and K.S. Hawk, eds. Appendices, IC1-IC56. Vol. 2 of

USDA Forest Service Pacific Southwest Region ecosystem management guidebook. San Francisco, CA.

Husari, S.J. and K.S. McKelvey. 1996. Fire-management policies and programs. Pp. 1101-1114 in: Status of the Sierra Nevada: Sierra Nevada Ecosystem Project Final Report to Congress Volume II. Wildland Resources Center Report No. 37. Center for Water and Wildland Resources. University of California, Davis.

Huston, M. 1979. A general hypothesis of species diversity. The American Naturalist 113: 81-101.

Jackson, W. D. 1968. Fire, air, earth and water – and elemental ecology of Tasmania. Proceedings of the Ecological Society of Australia **3**: 9-16.

Jacobs, D.F., D.W. Cole and J.R. McBride. 1985. Fire history and perpetuation of natural coast redwood ecosystems. Journal of Forestry 83: 494-497.

Jimerson, T. M. 1990. A seral stage and successional pathway model for the tanoak-canyon live oak/evergreen huckleberry ecological type on the Gasquet Ranger District, Six Rivers National Forest. Dissertation. University of California, Berkeley, California, USA.

Jimerson, T.M. 1990. A seral stage and successional pathway model for the tanoak-canyon live oak/evergreen huckleberry ecological type on the Gasquet Ranger District, Six Rivers National Forest. Ph.D. dissertation, University of California, Berkeley, CA.

Johnson, E. A. 2003. Towards a sounder fire ecology. Frontiers in Ecology and Environment **1**: 271.

Johnson, E. A., Miyanishi, K., and S. R. J. Bridge. 2001. Wildfire regime in the boreal forest and the idea of suppression and fuel buildup. Conservation Biology 15:1554-1557.

Kauffman, J.B. 1990. Ecological relationships of vegetation and fire in Pacific Northwest forests. Pp. 39-54 in: Walstad, J.D., S.R. Radosevich and D.V. Sandberg, eds. Natural and prescribed fire in Pacific Northwest forests. Oregon State University Press, Corvallis, OR.

Kaufmann, M.R., L.S. Huckaby, C.L. Regan and J. Popp. 1998. Forest reference conditions for ecosystem management in the Sacramento Mountains, New Mexico. USDA Forest Service Rocky Mountain Research Station Gen. Tech. Report RMRS-GTR-19. Fort Collins, CO.

Keane, R.E., S.F. Arno and J.K. Brown. 1990. Modelling stand dynamics in whitebark pine (*Pinus albicaulis*) forest. Ecol. Modelling 51: 73-95.

Keeler-Wolf, T. 1985. Ecological survey of the proposed Bridge Creek Research Natural Area, Klamath National Forest, Siskiyou County, California. Unpublished report on file with Pacific Southwest Research Station, Berkeley, CA.

Keeler-Wolf, T. 1990. Ecological surveys of Forest Service Research Natural Areas in California. USDA Forest Service Pacific Southwest Research Station Gen. Tech. Report PSW-125. Berkeley, CA.

Keeley, J. E. 2000. Chaparral. Pages 204-253 in M. G. Barbour and W. D. Billings (editors) North American Terrestrial Vegetation, 2nd Edition. Cambridge University Press, Cambridge, U.K.

Keeley, J. E. 2000. Chaparral. Pages 204-253 in M. G. Barbour and W. D. Billings (editors) North American Terrestrial Vegetation, 2nd Edition. Cambridge University Press, Cambridge, U.K.

Keeley, J. E. 2002. Fire management of California shrubland landscapes. Environmenatal Management 29: 395-408.

Keeley, J. E. and N. L. Stephenson. 2000. Restoring natural fire regimes to the Sierra Nevada in an era of global change. In: Cole, David N.; McCool, Stephen F.; Borrie, William T.; O'Loughlin, Jennifer, comps. Wilderness science in a time of change conference—Volume 5: Wilderness ecosystems, threats, and management; 1999 May 23–27; Missoula, MT. Proceedings RMRS-P-15-VOL-5. Ogden, UT: U.S. Departmentof Agriculture, Forest Service, Rocky Mountain Research Station.

Keeley, J.E., Ne'eman, G. & Fotheringham, C.J. (1999). Immaturity risk in a fire-dependent pine. J. Mediterr. Ecol., 1, 41-48.

Keeley, Jon E., Lubin, Daniel, Fotheringham, C. J.. 2003: Fire and grazing impacts on plant diversity and alien plant invastions in the southern Sierra Nevada. Ecological Applications 13: 1355–1374.

Keifer, M. 1991. Age structure and fire disturbance in southern Sierra Nevada subalpine forests. MS Thesis, Univ. of Arizona, 111 pp.

Key, J. 2000. Effects of clearcuts and site preparation on fire severity, Dillon Creek Fire 1994. Master's Thesis, Department of Forestry, Humboldt State University, Arcata, CA.

Kilgore, B.M. 1971. The role of fire in managing red fir forests. Transactions North American Wildlife and Natural Resources Conference 36: 405-416.

Kilgore, B.M. and D. Taylor. 1979. Fire history of a Sequoia mixed-conifer forest. Ecology 60:129-142.

Kondolf, G.M., R. Kattelman, M. Embury and D.C. Erman. 1996. Status of riparian habitat. Pp. 1009-1030 in: Status of the Sierra Nevada: Sierra Nevada Ecosystem Project Final Report to Congress Volume II. Wildland Resources Center Report No. 37. Center for Water and Wildland Resources. University of California, Davis.

LaLande, J. 1980. Prehistory and history of the Rogue River National Forest: A cultural resource overview. USDA Forest Service, Rogue River National Forest, Medford, OR.

LaLande, J. 1991. The indians of southwestern Oregon: An ethnohistorical review. Anthropology Northwest, No. 6. Oregon State University, Dept. of Anthropology, Corvallis, OR.

LaLande, J. 1995. An environmental history of the Little Applegate River watershed, Jackson County, Oregon. Rogue River National Forest, Medford, OR. 56 pp.

LaLande, J. and R. Pullen. 1999. Burning for a "Fine and Beautiful Open Country": Native uses of fire in southwestern Oregon. Pp. 255-276 in: R. Boyd, ed. Indians, fire and the land in the Pacific Northwest. Oregon State University Press, Corvallis, OR.

Landres, P.B., P. Morgan and F.J. Swanson. 1999. Overview of the use of natural variability concepts in managing ecological systems. Ecological Applications 9(4): 1179-1188.

Laudenslayer, W.F. and C.N. Skinner. 1995. Past climates, forests and disturbances of the Sierra Nevada, California: Understanding the past to manage for the future. Transactions of the

Laudenslayer, W.F., H.H. Darr and S. Smith. 1990. Historical effects of forest management practices on eastside pine communities in northeastern California. Pp. 26-34 in: A. Tecle, *et al.*, eds. Multi-resource management of ponderosa pine forests. USDA Forest Service, Rocky Mountain Research Station, Gen. Tech. Report RM-185, Flagstaff, AZ.

Lehmkuhl, J.F. *et al.* 1995. Assessment of terrestrial ecosystems in eastern Oregon and Washington: The Eastside Forest Ecosystem Health Assessment. Pp. 87-100 in: R.L. Everett and D.M. Baumgartner, eds. Symposium Proceedings: Ecosystem Management in Western Interior Forests. May 3-5, 1994, Spokane, WA. Washington State University Cooperative Extension, Pullman, WA.

Leiberg, J.B. 1900. The Cascade Range and Ashland Forest Reserves and adjacent regions. Pp. 219-293 in: Extract from the Twenty-first annual report of the U.S. Geological Survey, 1899-1900, Part V, Forest Reserves. Department of the Interior, U.S. Geological Survey. Government Printing Office, Washington, D.C.

Lewis, H.T. 1973. Patterns of Indian burning in California: Ecology and ethnohistory. Anthropological Paper No. 1. Balleena Press, Santa Barbara, CA.

Lewis, H.T. 1990. Reconstructing patterns of Indian burning in southwest Oregon. In: Living with the land: The Indians of southwest Oregon. Southern Oregon Historical Society. Medford, OR.

Lewis, H.T. 1993. Patterns of Indian burning in California: Ecology and ethnohistory. Pp. 55-116 in: T.C. Blackburn and K. Anderson, eds. Before the wilderness: Environmental management by native Californians. Balleena Press, Menlo Park, CA.

Lindenmayer, D.B., and J.F. Franklin. 2002. Conserving forest biodiversity – a comprehensive multiscaled approach. Island Press. Washington, DC. 351 pp.

Mack, M. C., and C. M. D'Antonio. 1998. Impacts of biological invasions on disturbance regimes. Trends in Ecology & Evolution 13: 195-198.

Malanson, G.P. 1984. Intensity as the third factor of disturbance regime and its effect on species diversity. *Oikos* 43: 411-413.

Manley, P.A., J.A. Fites-Kaufman, M.G. Barbour and M.D. Schlesinger. 2000. Biological integrity. Chapter 5 of Lake Tahoe Watershed Assessment, Lake Tahoe Basin Management Unit, South Lake Tahoe, CA. Available online at: http://www.r5.fs.fed.us/ltbmu/graphics/pres_actions/commitments/watershed_assess/wa

Manley, P.N. *et al.* 1995. Sustaining ecosystems: A conceptual framework. Version 1.0 USDA Forest Service Pacific Southwest Research Station, R5-EM-TP-001. San Francisco, CA.

Martin, I.B., D.T. Hodder and C. Whitaker. 1981. Overview of the cultural historic resources of Euro-American and other immigrant groups of the Shasta-Trinity National Forest. Final Report, Contract 53-9A28-9-2974. Geoscientific Systems and Consulting, Playa del Rey, CA. 198 pp.

Martin, R.E. 1997. Fire as an integral component of Siskiyou ecology. Pp. 86-89 in: Proceedings of the Conference on Siskiyou Ecology, May 30-June 1, 1997, Kerby, OR. Published by Siskiyou Regional Education Project, Cave Junction, OR.

Martin, R.E. and D.B. Sapsis. 1992. Fires as agents of biodiversity: Pyrodiversity promotes biodiversity. Pp. 150-157 in: Kerner, H.M. ed. Proceedings of the Symposium on Biodiversity of Northwestern California, Oct. 28-30, 1991, Santa Rosa, CA. Wildland Resources Center Report 29, Berkeley, CA

Martinson, E. J. and P. N. Omi. 2003. Performance of fuel treatments subjected to wildfires. Pages 7-14 in P. N. Omi and L. A. Joyce, technical eds. Fire, Fuel treatments and Ecological Restoration: Conference Proceedings. USDA Forest Service RMRS-P-29. Rocky Mountain Research Station, Fort Collins, Co

Maruoka, K.R. and J.K. Agee. 1994. Fire histories: Overview of methods and applications. Tech Notes from the Blue Mountains Natural Resources Institute. BMNRI-TN-2. La Grande, OR.

Mastrogiuseppe, R.J. and J.D. Mastrogiuseppe. 1999. Effects of prescribed fire in mixed conifer forest, Crater Lake National Park, Oregon. Internet site: <http://www.nps.gov/crla/clnp-fr.html>.

Mastrogiuseppe, R.J. and J.D. Mastrogiuseppe. 1999. Fire history of the northeastern portion of Crater Lake National Park, Oregon. Internet site: <http://www.nps.gov/crla/clnp-fr.html>.

McBride, J.R. and D.F. Jacobs. 1980. Land use and fire history in the mountains of southern California. pp. 85-88. In: M.A. Stokes and J.H. Dieterich (tech. coord.). Proceedings of the Fire History Workshop. October 20-24, 1980, Tucson, Arizona. USDA Forest Service, GTR-RM-81.

McClaren, M.P. and J.W. Bartolome. 1989. Fire-related recruitment in stagnant *Quercus douglasii* populations. Canadian Journal of Forest Research 19:580-585.

McCutchan, M.H. 1977. Climatic features as a fire determinant. In: Proceedings of the Symposium on the Environmental Consequences of Fire and Fuel Management in Mediterranean Ecosystems. USDA Forest Service Gen. Tech. Report WO-3. Washington, D.C.

McDonald, J.A. 1979. Cultural resource overview, Klamath National Forest, California. USDA Forest Service, Klamath National Forest, Yreka, CA. 131 pp.

McDonald, P.M. and J.C. Tappeiner. 1996. Silviculture-ecology of forest-zone hardwoods in the Sierra Nevada. Pp. 621-634 in: Status of the Sierra Nevada: Sierra Nevada Ecosystem Project Final Report to Congress Volume III. Wildland Resources Center Report No. 37. Center for Water and Wildland Resources. University of California, Davis.

McIver, J.D. and L. Starr. 2000. Environmental effects of post-fire logging: Literature review and annotated bibliography. USDA Forest Service Pacific Northwest Research Station, Gen. Tech. Report PNW-GTR-486. Portland, OR.

McKelvey, K.S. and K.K. Busse. 1996. Twentieth-century fire patterns on Forest Service lands. Pp. 1119-1138 in: Status of the Sierra Nevada: Sierra Nevada Ecosystem Project Final Report to Congress Volume II. Wildland Resources Center Report No. 37. Center for Water and Wildland Resources. University of California, Davis.

McKenzie, D., Z. Gedalof, D.L. Peterson, and P. Mote. 2004. Climate change, wildfire, and conservation. Conservation Biology: in press.

McKinley, G. and D. Frank. 1995. Stories on the land: An environmental history of the Applegate and upper Illinois Valleys. Report prepared for the Bureau of Land Management, Medford District, Medford, OR.

McNeil, R.C. and D.B. Zobel. 1980. Vegetation and fire history of a ponderosa pine - white fir forest in Crater Lake National Park. Northwest Science 54(1): 30-46.

Means, J.E. 1982. Developmental history of dry coniferous forests in the western Oregon Cascades. Pp. 142-158 in: J.E. Means, ed. Forest succession and stand development research in the Northwest. Oregon State University, Forest Research Laboratory, Corvallis, OR.

Means, J.E., J.H. Cissel and F.J. Swanson. 1996. Fire history and landscape restoration in Douglas-fir ecosystems of western Oregon. Pp. 61-67 in: Hardy, C.C. and S.F. Arno, eds. The use of fire in forest restoration. USDA Forest Service Intermountain Research Station Gen. Tech. Report INT-GTR-341. Ogden, UT.

Mensing, S.A. 1992. The impact of European settlement on blue oak (*Quercus douglasii*) regeneration and recruitment in the Tehachapi Mountains, California. Madroño 39:36-46.

Meyer, G. A., and J. L. Pierce. 2003. Climatic controls on fire-induced sediment pulses in Yellowstone National Park and Central Idaho: a long-term perspective. Forest Ecology and Management 178: 89-104.

Millar, C. I. And W. B. Woolfenden. 1999. The role of climate change in interpreting historical variability. Ecological Applications 9: 1207-1216.

Millar, C.I. and W.B. Woolfenden. 1999a. Sierra Nevada forests: Where did they come from? Where are they going? What does it mean? Transactions 64th North American Wildlife and Natural Resources Conference: 207-237.

Miller, C. 2003. Wildland fire use: a wilderness perspective on fuel management. Pages 379-386 in P. N. Omi and L. A. Joyce, technical eds. Fire, Fuel treatments and Ecological Restoration: Conference Proceedings. USDA Forest Service RMRS-P-29. Rocky Mountain Research Station, Fort Collins, Co.

Miller, C. and D. L. Urban. 2000. Modeling the effects of fire management alternatives on Sierra Nevada mixed-conifer forests. Ecological Applications 10: 85-94.

Miller, T.E. 1982. Community diversity and interactions between size and frequency of disturbance. American Naturalist 120: 533-536.

Minnich, R. A., M. G. Barbour, J. H. Burk and J. Sosa-Ramírez. 2000. Californian mixed-conifer forests under unmanaged fire regimes in the Sierra San Pedro Mártir, Baja California, Mexico. Journal of Biogeography 27: 105-129.

Minnich, R.A. 1980. Wildfire and the geographic relationships between canyon live oak, coulter pine and bigcone Douglas-fir forests. Pp. 55-61 in: Proceedings of the symposium on the ecology, management, and utilization of California oaks. USDA Forest Service Pacific Southwest Research Station, Gen. Tech. Report PSW-44. Berkeley, CA.

Minore, D. 1978. The Dead Indian Plateau: A historical summary of forestry observations and research in a severe southwestern Oregon environment. USDA Forest Service Pacific Northwest Research Station Gen. Tech. Rep. PNW-72. Portland, OR.

Minore, D. 1979. Comparative autecological characteristics of northwestern tree species: A literature review. USDA Forest Service Pacific Northwest Research Station Gen. Tech. Report PNW-87. Portland, OR.

Mohr, J. A., C. Whitlock, and C. N. Skinner. 2000. Postglacial vegetation and fire history, eastern Klamath Mountains, California. The Holocene 10: 587-601.

Moir, W.H. and T.H. Mowrer. 1995. Unsustainability. Forestry, Ecology and Management 73: 239-248.

Moore, M.M., W.W. Covington and P.Z. Fule. 1999. Reference conditions and ecological restoration: a southwestern ponderosa pine perspective. Ecological Applications 9(4): 1266-1277.

Moreno, J. M., and W. C. Oechel. 1993. Demography of *Adenostoma fasciculatum* after fires of different intensities in southern California chaparral. Oecologia 96: 95-101.

Morford, L. 1984. 100 years of wildland fires in Siskiyou County, California.

Morgan, P. and S.C. Bunting. 1990. Fire effects in whitebark pine forests. Pp. 166-170 in: W.C. Schmidt and K.T. McDonald, compilers. Proceedings – Symposium on whitebark pine ecosystems: Ecology and management of a high-mountain resource; March 29-31, 1989, Bozeman, MT. USDA Forest Service Intermountain Research Station Gen. Tech. Report INT-270. Ogden, UT.

Morgan, P., G.H. Aplet, J.B. Haufler, H.C. Humphries, M.M. Moore and W.D. Wilson. 1994. Historical range of variability: A useful tool for evaluating ecosystem change. Journal of Sustainable Forestry 2(1/2): 87-112.

Moritz, M A., J. E. Keeley, E. A. Johnson, and A. A. Schaffner. 2004. Testing a basic assumption of shrubland fire management: does the hazard of burning increase with the age of fuels? Frontiers in Ecology and Environment: in press.

Moritz, M. A. 2003. Spatio-temporal analysis of controls on shrubland fire regimes: age dependency and fire hazard. Ecology 84: 351-361.

Moritz, M. A. and D. C. Odion (in review). Examining the strength and possible causes of the relationship between fire history and Sudden Oak Death. Submitted to Oecologia.

Morris, W.G. 1934a. Forest fires in western Oregon and Washington. Oregon Historical Quarterly 35: 313-339.

Morris, W.G. 1934b. Lightning storms and fires on the national forests of Oregon and Washington. Unpublished report on file at USDA Forest Service Pacific Northwest Research Station, Portland, OR.

Morrison, P. and F.J. Swanson. 1990. Fire history and pattern in a Cascade Range landscape. USDA Forest Service Pacific Northwest Research Station Gen. Tech. Report PNW-GTR-254. Portland, OR.

Muir, J. 1901. Our National Parks. Houghton, Mifflin and Co., Boston, Ma.

Naiman, R.J., H. DeCamps and M. Pollock. 1993. The role of riparian corridors in maintaining regional biodiversity. Ecological Applications 3: 209-212.

Nives, S.L. 1989. Fire behavior on the forest floor in coastal redwood forests, Redwood National Park. Thesis, Humboldt State University, Arcata, CA.

Norman, S. and A.H. Taylor. In press. Variation in fire-return intervals across a mixed-conifer forest landscape. In: Proceedings of fire in California ecosystems: Integrating ecology, prevention and management. Nov. 17-20, 1997, San Diego, CA.

Noss, R.F., ed. The redwood forest: History, ecology and conservation of the coast redwoods. Island Press, Washington, D.C.

Noss, R.F., J.R. Strittholt, K. Vance-Borland, C. Carroll and P.A. Frost. 1999a. A conservation plan for the Klamath-Siskiyou Ecoregion. Natural Areas Journal 19(4): 392-411.

Odion, D. C. 2000. Seed banks of long-unburned stands of maritime chaparral: Composition, germination behavior and survival with fire. Madroño 47: 195-203.

Odion, D. C., J. R. Strittholt, H. Jiang, E. J. Frost, D. A. DellaSala, and M. A. Moritz. 2004. Patterns of fire severity and forest conditions in the Klamath Mountains, Northwestern California. Conservation Biology In Press.

Odion, D.C., and F.W. Davis. 2000. Fire, soil heating, and the formation of vegetation patterns in chaparral. Ecological Monographs 70: 149-169.

Odion, D.E. & Tyler, C. (2002). Are long fire-free periods needed to maintain the endangered, fire-recruiting shrub *Arctostaphylos morroensis* (Ericaceae)? *Conserv. Ecol*., 6, http://www.consecol.org/vol6/iss2/art4.

Odion, Dennis C. and Karen Haubensak, In Press. Response of French broom to fire. Fire in California Ecosystems: Integrating Ecology, Prevention, and Management, 1997, San Diego, CA. International Association of Wildland Fire, Fairfield, WA. http://www.ice.ucdavis.edu/cafe/agenda97/FireEcology/Plants/4feOdion.html

Odion, Dennis C., James R. Strittholt, Hong Jiang, Evan J. Frost, Dominick A. DellaSala, and Max A. Moritz. 2004. Fire and Vegetation Dynamics in the Western Klamath Mountains. Second Conference on Klamath-Siskiyou Ecology. In press.

Olson, R.D. 1994. Lassen National Forest fire history. Unpublished report on file with Lassen National Forest, Susanville, CA.

Omi, P.N. 1996. The role of fuelbreaks. Pp. 89-96 in: Proceedings – Seventeenth Annual Forest Vegetation Management Conference, Redding, CA.

Parker V. T., and C. Rogers 1988. Chaparral burns and management: influence of soilmoisture at the time of a prescribed chaparral burn on the response of the native vegetation from the seed bank. California Department of Fish and Game, Sacramento Ca., USA.

Parker, V.T. 1987. Can native flora survive prescribed burns? Fremontia 15(2): 3-6.

Parks, D.S. and T.W. Cundy. 1989. Soil hydraulic characteristics of a small southwest Oregon watershed following high-intensity fire. Pp. 63-67 in: N.H. Berg, tech. Coord. Proceedings of the symposium on fire and watershed management, October 26-28, 1988, Sacramento, CA. USDA Forest Service, Pacific Southwest Research Station, Gen. Tech. Rep. PSW-109. Berkeley, CA.

Parsons, D. J. D. M. Graber, J. K. Agee, and J. W. van Wagtendonk. 1986. Natural fire management in national parks. Environmental Management 10: 21-24.

Paysen, T. E., and J. D. Cohen. Chamise chaparral dead fuel fraction is not reliably predicted by age. Western Journal of Applied Forestry 5: 127-131.

Perry, D. A. 1995 . Self-organizing systems across scales. Trends in Ecology & Evolution. 10: 241-244.

Perry, D. A. and M. P. Amaranthus. 1997. Disturbance, recovery, and stability. Pages 31-56 in K.A. Kohm and J. F. Franklin eds. Creating a Forestry for the 21st Century. Island Press, Covelo, Ca.

Perry, D.A. 1994. Forest ecosystems. The John Hopkins Press. Baltimore, MD.

Perry, D.A. 1995a. Landscapes, humans, and other ecosystem-level considerations: a discourse on ecstasy and laundry. In R.L. Everett and D.M. Baumgartner, eds. Symposium Proceedings: Ecosystem Management in Western Interior Forests. May 3-5, 1994, Spokane, WA. Washington State University Cooperative Extension, Pullman, WA Pp. 177-192.

Perry, D.A. 1995b. Self-organizing systems across scales. Trends in Ecology and Evolution. 10: 241-244.

Pickford, S.G. 1981. West-side true fir and prescribed fire. Pp. 315-318 in: C.D. Oliver and R.M. Kenady, eds. Proceedings of the biology and management of true fir in the Pacific Northwest. Inst. of Forest Res. Contrib. 45, University of Washington, Seattle, WA.

Pillers, M.D. 1989. Fine fuel dynamics of old-growth redwood forests. Thesis, Humboldt State University, Arcata, CA.

Pitcher, D. 1981. The ecological effects of fire on stand structure and fuel dynamics in red fir forests of Mineral King, Sequoia National Park, California. MS Thesis, UC Berkeley, 168 pp.

Pitcher, D. 1987. Fire History and Age Structure in Red Fir Forests of Sequoia National Park, California. Canadian Journal of Forest Research 17:582-587.

Pullen, R. 1996. Overview of the environment of native inhabitants of southwestern Oregon, late prehistoric era. Report prepared for USDA Forest Service, Rogue River and Siskiyou National Forests, and USDI Bureau of Land Management, Medford District. Pullen Consulting, Bandon, OR.

Pyne, S.J. 1982. Fire in America – A cultural history of wildland and rural fire. Princeton University Press, Princeton, NJ.

Pyne, S.J., P.L. Andrews and R.D. Laven. 1996. Introduction to Wildland Fire. Second Edition. John Wiley & Sons, Inc. New York, NY.

Reed, L.J. and N.G. Sugihara. 1987. Northern oak woodlands – ecosystem in jeopardy or is it

Reider, D. A. 1988. California conflagration—recounting the siege of '87. Journal of Forestry 86: 5-8.

Rice, C.L. 1990. Fire history and ecology of the North Coast Range Preserve. Pp. 367-372 in: Lotan, J.E. *et al.*, eds. Proceedings – Wilderness Fire Symposium, Nov. 15-18, 1983, Missoula, MT. USDA Forest Service Intermountain Forest and Range Experiment Station, Gen. Tech. Rep. INT-GTR-182. Missoula, MT.

Riegel, G.M, B.G. Smith and J.F. Franklin. 1991. Foothill oak woodlands of the interior valleys of southwestern Oregon. Northwest Science 66(2): 66-76.

Ringland, A. 1916. Report on fire protection problems of the Klamath and Crater National Forests. Item No. D-9, historical records collection of the Rogue River National Forest, Medford, OR.

Romme, W. H., L. Floyd-Hanna, and D. D. Hanna. 2003. Ancient pinyon-juniper forests of Mesa Verde and the west: a cautionary note for forest restoration programs. Pages 335-351 in P. N. Omi and L. A. Joyce, technical eds. Fire, Fuel treatments and Ecological Restoration: Conference Proceedings. USDA Forest Service RMRS-P-29. Rocky Mountain Research Station, Fort Collins, Co

Rothermel, R.C. 1983. How to predict the spread and intensity of wildfires. USDA Forest Service Intermountain Research Station Gen. Tech. Report INT-143. Ogden, UT.

Rundel, P.W., D.W. Parsons and D.T. Gordon. 1977. Montane and subalpine vegetation of the Sierra Nevada and Cascade Ranges. Pp. 559-600 in: M.G. Barbour and J. Major, eds. Terrestrial vegetation of California. Wiley-Interscience, New York, NY.

Russell, E.W.B. 1997. People and the land through time: Linking ecology and history. Yale University Press, Cambridge, MA.

Russell, W. H., J. McBride, and R. Rowntree. Revegetation after four stand-replacing fires in the Tahoe Basin. Madrono 45: 40-46.

Russell-Smith, J., P. G. Ryan, D. C. Cheal. 2002. Fire regimes and the conservation of sandstone heath in monsoonal northern Australia: frequency, interval, patchiness. Biological Conservation **104**: 91-106.

Sampson, A. W. 1944. Plant succession on burned chaparral lands in northern California. University of California Agricultural Experiment Station Bulletin **685**.

Sapsis, D.B. and C. Brandow. 1997. Turning plantations into healthy, fire resistant forests: Outlook for the Granite Burn. California Department of Forestry and Fire Protection, Fire and Resource Assessment Program, Internet site http://frap.cdf.ca.gov/projects/granite_burn/gb.html

Sapsis, D.B. and R.E. Martin. 1993. Fire, the landscape and diversity: A theoretical framework for managing wildlands. Pp. 270-278 in: 12th Conference on Fire and Forest Meteorology, October 26-28, 1993, Jekyll Island, GA.

Sawyer, J. O., D. A. Thornburgh and J. R. Griffin. 1977. Mixed evergreen forest. Pages 359-381 in M.G. Barbour and J. Major, editors. Terrestrial vegetation of California. Wiley-Interscience, reprinted by the California Native Plant Society 1988. Sacramento, California, USA

Sawyer, J.O. 1980. Douglas-fir – tanoak – Pacific madrone. Pp. 111-112 in: F.H. Eyre, ed. Forest cover types of the United States and Canada. Society of American Foresters, Washington, D.C.

Sawyer, J.O. and D.A. Thornburgh. 1970. The ecology of relict conifers in the Klamath region, California. Unpublished report on file at USDA Forest Service Pacific Southwest Research Station, Berkeley, CA.

Sawyer, J.O. and D.A. Thornburgh. 1977. Montane and subalpine vegetation of the Klamath Mountains. Pp. 699-732 in: M.G. Barbour and J. Major, eds. Terrestrial vegetation of California. Wiley-Interscience, reprinted by the California Native Plant Society 1988. Sacramento, CA.

Sawyer, J.O. and T. Keeler-Wolf. 1995. A manual of California vegetation. California Native Plant Society, Sacramento, CA.

Sawyer, J.O., S.C. Sillett, J.H. Popenoe, A. LaBanca, T. Sholars, D.L. Largent, F. Euphrat, R.F. Noss and R. Van Pelt. 1999a. Characteristics of redwood forests. Pp. 39-80 in: R.F. Noss, ed. The redwood forest: History, ecology and conservation of the coast redwoods. Island Press, Washington, D.C.

Sawyer, J.O., S.C. Sillett, W.J. Libby, T.E. Dawson, J.H. Popenoe, D.L. Largent, R. Van Pelt, S.D. Veirs, R.F. Noss, D.A. Thornburgh and P. Del Tredici. 1999b. Redwood trees, communities and ecosystems: A closer look. Pp. 81-118 in: R.F. Noss, ed. The redwood forest: History, ecology and conservation of the coast redwoods. Island Press, Washington, D.C.

Schroeder, M.J. and C.C. Buck. 1970. Fire weather: A guide for application of meteorological information to forest fire control operations. USDA Forest Service Agriculture Handbook 360, Washington, D.C.

Sheppard, P.R. 1984. Fire regime of the lodgepole pine (*Pinus contorta* var. *murrayana*) forests of the Mt. San Jacinto State Park wilderness, California. MS Thesis, Cornell University, NY. 93 pp.

Show, S. B., and E. I. Kotok. 1924. The role of fire in California pine forests. U.S. Department of Agriculture Bulletin 1294.

Sierra Nevada Ecosystem Project (SNEP). 1996. Status of the Sierra Nevada: Sierra Nevada

Skinner, C. N. 1995. Change in spatial characteristics of forest openings in the Klamath Mountains of northwestern California, USA. Landscape Ecology 10: 219-228.

Skinner, C. N. and C. Chang. 1996. Fire regimes, past and present. Pages 1041-1069 in Sierra Nevada Ecosystem Project, Final Report to Congress, Volume II. University of California, Davis, Centers for Water and Wildland Resources.

Skinner, C.N. 1978. An experiment in classifying fire environments in Sawpit Gulch, Shasta County, California. M.A. Thesis in Geography, California State University, Chico, CA.

Skinner, C.N. 1994. Fire return intervals in the eastern Klamath Mountains, California. Pp. 352-353 in: Abstracts from the Association of American Geographers 90th Annual Meeting, 29 March - 2 April, 1994, Washington, D.C.

Skinner, C.N. 1995a. Using prescribed fire to improve wildlife habitat near Shasta Lake, California. Unpublished report, Pacific Southwest Research Station, Redding, CA.

Skinner, C.N. 1995b. Change in spatial characteristics of forest openings in the Klamath Mountains of northwestern California, USA. Landscape Ecology 10(4): 219-228.

Skinner, C.N. 1997. Toward an understanding of fire history information. Pp. 15-22 in: Sommarstrom, S., ed. Proceedings of the Sixth Biennial Watershed Management Conference, University of California Water Resources Center, Report No. 92. Berkeley, CA.

Skinner, C.N. and A.H. Taylor. 1997. Fire regimes and management of old-growth Douglas-fir forests in the Klamath Mountains of northwestern California. Pp. 203-208 in: J.E. Greenlee, *et al.*, eds. Proceedings – Fire effects on Threatened and Endangered species and habitats conference, Nov. 13-16, Coeur D'Alene, ID. International Association of Wildland Fire, Fairfield, WA.

Skinner, C.N. and C. Chang. 1996. Fire regimes, past and present. Pp. 1041-1069 in: Status of the Sierra Nevada: Sierra Nevada Ecosystem Project Final Report to Congress Volume II. Wildland Resources Center Report No. 37. Center for Water and Wildland Resources. University of California, Davis.

Skinner, C.N. and C.P. Weatherspoon. 1996. Plantation characteristics affecting damage from wildfire. Pp. 137-142 in: Proceedings – 17th Annual Forest Vegetation Management Conference, Jan 16-18, 1996, Redding, CA.

Skinner, C.N. In press. Fire history in riparian reserves of the Klamath Mountains. In: Proceedings, Symposium on fire in California ecosystems: Integrating ecology, prevention and management, Nov. 17-20, 1997, San Diego, CA.

Smith, H.Y. and S.F. Arno, eds. 1999. Eighty years of change in a managed ponderosa pine forest. USDA Forest Service Rocky Mountain Research Station Gen. Tech. Report RMRS-GTR-23. Ogden, UT.

Smith, J.K. and W.C. Fisher. 1997. Fire ecology of the forest habitat types of northern Idaho. USDA Forest Service Intermountain Research Station Gen. Tech. Report INT-GTR-363. Ogden, UT.

SNEP. 1996. Sierra Nevada Ecosystem Project, Final Report to Congress: Status of the Sierra Nevada. University of California, Davis, Centers for Water and Wildland Resources, Davis, Ca.

Soulé, Peter T., Knapp, Paul A., Grissino-Mayer, Henri D. 2004: Human agency, environmental drivers, and western juniper establishment during the late Holocene. Ecological Applications. 14 96–112.

Stebbins, G.L., and J. Major. 1965. Endemism and speciation in the California flora. Ecological Monographs 35:1-35.

Stephens, S. L. and M.A. Finney. 2002. Prescribed fire mortality of Sierra Nevada mixed conifer tree species: effects of crown damage and forest floor combustion. Forest Ecology and Management 162: 261-271.

Stephens, S. L., C. N. Skinner, and S. J. Gill. 2003. Dendrochronology-based fire history of Jeffrey pine – mixed conifer forests in the Sierra San Pedro Martir, Mexico. Canadian Journal of Forest Research 33: 1090-1101.

Stephens, S.L. 1997. Fire history of a mixed conifer oak-pine forest in the foothills of the Sierra Nevada, El Dorado County, California. Pages 191-198 in N.H. Pillsbury, J. Verner, and W.D. Tietje (tech. coord.). Proceedings of a Symposium on Oak Woodlands: Ecology, Management, and Urban Interface Issues. 19-22 March 1996. San Luis Obispo, CA. USDA Forest Service, General. Technical. Report PSW-GTR-160. Pacific Southwest Research Station, Berkeley, Ca. 738 pp.

Stephenson, N. L. 1999. Reference conditions for giant Sequoia restoration, structure, process, and precision. Ecological Applications 9: 1250-1263.

Stephenson, N. L., D. J. Parsons, and T. W. Swetnam. 1991. Restoring natural fire the the Sequoia-Mixed conifer forest: should intense fire play a role? Pages 321-338 in Proceedings of the 17th Tall Timbers Fire Ecology Conference, May, 1989, Tallahassee, Florida

Stone, E. C. and G. Juhren. 1953. Fire stimulated germination. California Agriculture 7: 13-14.

Stone, E.C. and R.B. Vasey. 1968. Preservation of coast redwood on alluvial flats. Science 159: 157-161.

Strauss, D., L. Bednar, R. Mees. 1989. Do one percent of forest fires cause ninety-nine percent of the damage? Forest Science 35(2): 319-328.

Stuart, J. D., and L. A. Salazar. 2000. Fire history of white fir forests in the coastal mountains of northwestern California. Northwest Science 74: 280-285.

Stuart, J.D. 1987. Fire history of an old-growth forest of *Sequoia sempervirens* (Taxodiaceae) forest in Humboldt Redwoods State Park, California. Madrono 34: 128-141.

Stuart, J.D. and L.A. Salazar. 2000. Fire history of California white fir forests in the coastal mountains of northwestern California. Northwest Science 74: 280-285.

Stuart, J.D., L. Fox and G. Emery. 1993. Humboldt Redwoods State Park unit prescribed fire management plan: final report. Submitted to California Dept. of Parks and Recreation. Department of Forestry, Humboldt State University, Arcata, CA.

Stuart, J.D., M.C. Grifantini, and L. Fox III. 1993. Early successional pathways following wildfire and subsequent silvicultural treatment in Douglas-fir/hardwood forests, NW California. Forest Science 39: 561-572.

Sugihara, N.G. and J.R. McBride. 1992. Dynamics of sugar pine and associated species following non-stand replacing fires in white-fir dominated mixed conifer forests. Pp. 39-44, in: B.B. Kinloch, M. Marosy and M.E. Huddleston, eds. Sugar pine: status, values, and roles in ecosystems. Proceedings of a symposium presented by the California Sugar Pine Management Committee, March 30 - April 1, 1992, University of California-Davis. Univ. Calif. Division of Agriculture and Natural Resources, Publication 3362, Berkeley, CA.

Sugihara, N.G. and L.J. Reed. 1987. Prescribed fire for restoration and maintenance of bald hills oak woodlands. Pp. 446-451 in: USDA Forest Service Pacific Southwest Research Station, Gen. Tech. Report PSW-100. Berkeley, CA.

Sugihara, N.G., L.J. Reed and J.M. Lenihan. 1987. Vegetation of the Bald Hills oak woodlands, Redwood National Park, California. Madrono 34: 193-208.

Swanson, F.J., J.A. Jones and G.E. Grant. 1997. The physical environment as a basis for managing ecosystems. Chapter 15 in: K.A. Kohm and J.F. Franklin, eds. Creating a forestry for the 21st century. Island Press, Washington, D.C.

Swanson, F.J., R.P. Neilson and G.E. Grant. 1992. Some emerging issues in watershed management: Landscape patterns, species conservation and climate change. Pp. 307-323 in: R.J. Naiman, ed. Watershed management: Balancing sustainability and environmental change. Springer-Verlag, New York.

Swanson, F.J., T.K. Kratz, N. Caine and R.G. Woodhouse. 1988. Landform effects on ecosystem patterns and processes. Bioscience 38: 92-98.

Sweeney, J. R. 1956. Responses of vegetation to fire. University of California Publications in Botany 28:143-250.

Swetnam, T.W. 1993. Fire history and climate change in giant sequoia groves. Science 262: 885-889.

Swetnam, T.W. and C.H. Baisan. 1996. Historical fire regime patterns in the southwestern United States since AD 1700. Pp. 11-32 in: C.D. Allen, ed. Fire effects in southwestern forests, proceedings of the second La Mesa Fire symposium, March 29-31, 1994, Los Alamos, NM. USDA Forest Service Rocky Mountain Research Station Gen. Tech. Report RM-GTR-286.

Swetnam, T.W., C.D. Allen and J.L. Betancourt. 1999. Applied historical ecology: Using the past to manage for the future. Ecological Applications 9(4): 1189-1206.

Swetnam, T.W., C.H. Baisan, A.C. Caprio, R. Touchan, and P.M. Brown. 1992. Tree-ring reconstruction of giant sequoia fire regimes. Final report to Sequoia, Kings Canyon and Yosemite National Parks, Laboratory of Tree-Ring Research, Tucson, AZ. 90 pp. + appendices.

Swetnam, T.W., R. Touchan, C.H. Baisan, A.C. Caprio, and P.M. Brown. 1991. Giant sequoia fire history in Mariposa Grove, Yosemite National Park. In Yosemite Centennial Symposium, Proceedings: Natural Areas and Yosemite: Prospects for the Future, Oct. 13-20, 1990, Concord, Calif. NPS D-374.

Talbert, B.J. 1996. Management and analysis of 30-year continuous forest inventory data on the Six Rivers National Forest. Master's thesis, Humboldt State University, Arcata, CA.

Tande, G.F. 1979. Fire history and vegetation pattern of coniferous forests in Jasper National Park, Alberta. Canadian Journal of Botany 57: 1912-1931.

Tappeiner, J.C. and P.M. McDonald. 1984. Development of tanoak understories in conifer stands. Canadian Journal of Forest Research 14: 271-277.

Tappeiner, J.C., M. Newton, P.M. McDonald and T.B. Harrington. 1992. Ecology of hardwoods, shrubs and herbaceous vegetation: Effects on conifer regeneration. Pp. 136-164 in: S.D. Hobbs, ed. Reforestation practices in southwestern Oregon and northern California. Forest Research Laboratory, Oregon State University, Corvallis, OR.

Taylor, A. H. 2002. Evidence for pre-suppression high severity fire on mixed conifer forests on the West Shore of the Lake Tahoe Basin. Final report for the USDA Forest Service,Lake Tahoe Basin Management Unit.

Taylor, A.H. 1993. Fire history and structure of red fir *(Abies magnifica*) forests, Swain Mountain Experimental Forest, Cascade Range, northeastern California. Canadian Journal of Forest Research 23: 1672-1678.

Taylor, A.H. 1995. Fire history of the Caribou Wilderness, Lassen National Forest, California. Final report for cooperative agreement PSW-OOO6CA. USDA Forest Service, Pacific Southwest Research Station, PSW Silviculture Lab, Redding, CA.

Taylor, A.H. 2000. Fire regimes and forest changes across a montane forest compositional gradient, Lassen Volcanic National Park, southern Cascades, California. Journal of Biogeography 27: 87-104.

Taylor, A.H. and C.B. Halpern. 1991. The structure and dynamics of *Abies magnifica* forests in the southern Cascade Range, USA. Journal of Vegetation Science 2: 189-200.

Taylor, A.H. and C.N. Skinner. 1994. Fire history and fire regimes in the Klamath Mountains of California. Pp. 373 in: Abstracts from the Association of American Geographers 90th Annual Meeting, 29 March - 2 April, 1994, Washington, D.C.

Taylor, A.H. and C.N. Skinner. 1997. Fire regimes and management of old-growth Douglas-fir forests in the Klamath Mountains of northwestern California. Pp. 203-208 in: Proceedings, Fire effects on rare and endangered species and habitats conference, Nov 13-16, 1995. Couer d'Alene, ID. International Association of Wildland Fire, Fairfield, WA.

Taylor, A.H. and C.N. Skinner. 1998. Fire history and landscape dynamics in a late-successional reserve, Klamath Mountains, California, USA. Forest Ecology and Management 111: 285-301.

Taylor, A.H. and M.N. Solem. In press. Fire regimes in an upper montane forest landscape, Caribou Wilderness, southern Cascades, USA.

Taylor, A.H., and C.N. Skinner. 2003. Spatial and temporal patterns of historic fire regimes and forest structure as a reference for restoration of fire in the Klamath Mountains. Ecological Applications 13: 704-719.

Taylor, K.L. and R.W. Fonda. 1990. Woody fuel structure and fire in subalpine fir forests, Olympic National Park, Washington. Canadian Journal of Forest Research 20: 193-199.

Teensma, P.D.A. 1987. Fire history and fire regimes of the central western Cascades of Oregon. Ph.D. dissertation, University of Oregon, Eugene, OR.

Thilenius, J.F. 1968. The *Quercus garryana* forests of the Willamette Valley, Oregon. Ecology 49: 1124-1133.

Thomas, T.L. and J.K. Agee. 1986. Prescribed fire effects on mixed conifer forest structure at Crater Lake, Oregon. Canadian Journal of Forest Research 16: 1082-1087.

Thornburgh, D.A. 1982. Succession in the mixed evergreen forests of northwestern California. Pages 87-91 in J.E. Means, editor, Forest succession and stand development research in the Northwest. Oregon State University, Forest Research Laboratory, Corvallis.

Thornburgh, D.A. 1982. Succession in the mixed evergreen forests of northwestern California. Pp. 87-91 in: J.E. Means, ed. Forest succession and stand development research in the Northwest. Oregon State University, Forest Research Laboratory, Corvallis, OR.

Thornburgh, D.A. 1995. The natural role of fire in the Marble Mountains Wilderness. Pp. 273-274 in: Proceedings of the Symposium on Fire in Wilderness and Park Management. USDA Forest Service, Intermountain Research Station, Gen. Tech. Rep. INT-GTR-320. Ogden, UT.

Toth, E., J. Laboa, D. Nelson, R. Hermit and R.S. Andrews, eds. 1994. Ecological support team workshop proceedings for the California Spotted Owl Environmental Impact Statement. USDA Forest Service, Pacific Southwest Regional Office, San Francisco, CA.

Turner, M. G., and W. H. Romme. 1994. Landscape dynamics in crown fire ecosystems. Landscape Ecology. 9: 59-77.

Turner, M. G., W. H. Romme and D. B. Tinker. 2003. Surprises and lessons from the 1988 Yellowstone fires. Frontiers in Ecology and Environment 1: 351-358.

U.S. General Accounting Office. 1999. Western national forests: A cohesive strategy is needed to address catastrophic wildfire threats. GAO/RCED-99-65. Washington, D.C.

USDA Forest Service 1999b. Fire Management Plan, Kalmiopsis Wilderness, Siskiyou National Forest. Grants Pass, OR.

USDA Forest Service. 2000. Protecting People and Sustaining Resources in Fire Adapted Ecosystems, A Cohesive Strategy. USDA Forest Service, Washington D.C.

USDA Forest Service. 1988. Silver Fire Recovery Plan. Siskiyou National Forest, Grants Pass, OR.

USDA Forest Service. 1994. Final Environmental Impact Statement for the Land and Resource Management Plan, Klamath National Forest. Siskiyou County, California and Jackson County, Oregon. Yreka, CA.

USDA Forest Service. 1995. Dillon Creek Watershed Analysis. USDA Forest Service Pacific Southwest Region, Klamath National Forest, Yreka, CA.

USDA Forest Service. 1996. National Forest Fire Report 1994. Washington, D.C.

USDA Forest Service. 1998. 1991-1997 Wildland fire statistics. Fire and Aviation Management, Washington, D.C.

USDA Forest Service. 1998b. Applegate Adaptive Management Area Guide. Rogue River and Siskiyou National Forests and Bureau of Land Management, Medford District. Medford,

USDA Forest Service. 1999. General Information, Big Bar and Megram Fires. Available at http://www.r5.fs.fed.us/sixrivers/fireinfo/fact_sheet.htm

USDA Forest Service. 2000. Forest Service Roadless Area Conservation. Draft Environmental Impact Statement Volume 1. USDA Forest Service, Washington, D.C.

Vale, T.R. 1998. The myth of the humanized landscape: An example from Yosemite National Park. Natural Areas Journal 18: 231-236.

van Norman, K.J. 1998. Historical fire regime of the Little River watershed, southwestern Oregon. Master's thesis, Department of Forest Science, Oregon State University, Corvallis, OR.

Van Wagner, C. E. 1977. Conditions for the start and spread of crownfire. Canadian Journal of Forest Research 7: 23-24.

van Wagtendonk, J.W. 1996. Use of a deterministic fire growth model to test fuel treatments. in Status of the Sierra Nevada: Sierra Nevada Ecosystem Project Final Report to Congress. Volume II. Wildland Resources Center Report No. 37. Center for Water and Wildland Resources. University of California, Davis.

van Wagtendonk, J.W. 1985. Fire suppression effects on fuels and succession in short-interval wilderness ecosystems. Pp. 119-126 in: Lotan, J.E. *et al.*, eds. Proceedings – Wilderness Fire Symposium, Nov. 15-18, 1983, Missoula, MT. USDA Forest Service Intermountain Forest and Range Experiment Station, Gen. Tech. Rep. INT-GTR-182. Missoula, MT.

van Wagtendonk, J.W. 1991. Spatial analysis of lightning strikes in Yosemite National Park. Pp. 605-611 in: P. Andrews and D.F. Potts, eds. Proceedings of the eleventh conference on fire and forest meteorology. Society of American Foresters, Bethesda, MD.

Veblen, T. T. 2003. Key issues in fire regime research for fuels management and ecological restoration. Pages 259-276 in P. N. Omi and L. A. Joyce, technical eds. Fire, Fuel treatments and Ecological Restoration: Conference Proceedings. USDA Forest Service RMRS-P-29. Rocky Mountain Research Station, Fort Collins, Co

Veirs, S.D. 1980a. The role of fire in northern coast redwood forest dynamics. Pp. 190-209 in: Proceedings, Conference on scientific research in the national parks. Vol. 10, Fire Ecology. National Park Service, Washington, D.C.

Veirs, S.D. 1980b. The influence of fire in coast redwood forests. Pp. 93-95 in: Proceedings, fire history workshop. Tucson, AZ. USDA Forest Service, Rocky Mountain Research Station Gen. Tech. Report RM-81. Fort Collins, CO.

Veirs, S.D. 1982. Coast redwood forest: Stand dynamics, successional status, and the role of fire. Pp. 119-141 in: J.E. Means, ed. Forest succession and stand development research in the Northwest. Oregon State University Forest Research Lab, Corvallis, OR.

Veirs, S.D. 1985. Coast redwood fire ecology and prescribed fire management: Proceedings of a workshop held October 15-16, 1984, Arcata, CA. Cooperative Park Studies Unit, Redwood National Park, Arcata, CA.

Wagner, D.H. 1997. Klamath-Siskiyou region, California and Oregon, USA. Pp. 74-76 in: S.D. Davis, V.H. Heywood, O. Herrera-Macbryde, J. Villa-Lobos, and A.C. Hamilton, eds. Centres for plant diversity. Volume 3: the Americas. World Wildlife Fund for Nature and IUCN (World Conservation Union), Information Press, Oxford, England.

Wallace, D. R. 1983. The Klamath Knot. Sierra Club Books, San Francisco, Ca.

Walstad, J.D. 1992. History of the development, use and management of forest resources. Pp. 26-46 in: S.D. Hobbs, ed. Reforestation practices in southwestern Oregon and northern California. Forest Research Laboratory, Oregon State University, Corvallis, OR.

Waring, R. 1969. Forest plants of the eastern Siskiyous: Their environmental and vegetational distribution. Northwest Science 43: 1-17.

Waring, R.H., and W.H. Schlesinger. 1985. Forest Ecosystems: Concepts and Management. Academic Press, Orlando, Florida.

Warner, T.E. 1980. Fire History in the Yellow Pine Forest of Kings Canyon National Park. pp. 89-92. In: M.A. Stokes and J.H. Dieterich (tech. coord.). Proceedings of the Fire History Workshop. October 20-24, 1980, Tucson, Arizona. USDA Forest Service, General Technical Report RM-81.

Weatherspoon, C.P, S.J. Husari and J.W. van Wagtendonk. 1992. Fire and fuels management in relation to owl habitat in forests of the Sierra Nevada and southern California. Pp. 247-260 in: J. Verner *et al.*, eds. The California spotted owl: A technical assessment of its current status. USDA Forest Service Pacific Southwest Research Station Gen. Tech. Rep. PSW-GTR-133. Berkeley, CA.

Weatherspoon, C.P. 1996. Fire-silviculture relationships in Sierra forests. Pp. 1167-1176 in: Status of the Sierra Nevada: Sierra Nevada Ecosystem Project Final Report to Congress Volume II. Wildland Resources Center Report No. 37. Center for Water and Wildland Resources. University of California, Davis.

Weatherspoon, C.P. and C.N. Skinner. 1990. Damage from 1987 fires on the Hayfork Ranger District, Shasta-Trinity National Forest. FIR report 12(1): 11.

Weatherspoon, C.P. and C.N. Skinner. 1995. An assessment of factors associated with damage to tree crowns from 1987 wildfires in northern California. Forest Science 41(3): 430-451.

Weatherspoon, C.P. and C.N. Skinner. 1996. Landscape-level strategies for forest fuel management. Pp. 1471-1491 in: Status of the Sierra Nevada: Sierra Nevada Ecosystem Project Final Report to Congress Volume II. Wildland Resources Center Report No. 37. Center for Water and Wildland Resources. University of California, Davis.

Weatherspoon, C.P. and C.N. Skinner. In press. An ecological comparison of fire and fire surrogates for reducing wildfire hazard and improving forest health. Paper presented at Fire in California Ecosystems: Integrating Ecology, Prevention and Management, Nov. 17-20, 1997, San Diego, CA.

Weisberg, P.J. 1998. Fire history, fire regimes and development of forest structure in the central western Oregon Cascades. Ph.D. Dissertation, Department of Forest Science, Oregon State University, Corvallis, OR.

Weise, D.R., J.C. Ruggelbrugge, T.E. Paysen and S.G. Conard. In press. Fire occurrence on southern California national forests – has it changed recently? Paper presented at Fire in California Ecosystems: Integrating Ecology, Prevention and Management, Nov. 17-20, 1997, San Diego, CA.

White, D.E., T. Atzet and P. McCrimmon. In press. Fire regime variability by plant association in southwestern Oregon. In: Symposium on fire in California ecosystems, San Diego, CA [publication place and publisher unknown]

White, J. and J. Huhtala. 1997. Fifty years of cooperation on the control of forest fires: The McCloud River Lumber Company and the Shasta National Forest, 1904-1954. The Siskiyou Pioneer in Fact, Folklore and Fiction Vol. 6, No 10: 224 -232. Siskiyou County Historical Society, Yreka, CA..

White, P.S. and J.L. Walker. 1997. Approximating nature's variation: selecting and using reference information in restoration ecology. Restoration Ecology 5: 338-349.

Whitlock, C., S. L. Shafer, J. Marlon. 2003. The role of vegetation change in shaping past and future fire regimes in the northwest U.S. and the implications for ecosystem Management. Forest Ecology and Management 178: 5-21.

Whittaker, R.H. 1960. Vegetation of the Siskiyou Mountains, Oregon and California. Ecological Monographs 30: 279-338.

Whittaker, R.H. 1961. Vegetation history of the Pacific coast states and the central significance of the Klamath region. Madrono 16: 5-23.

Wills, R. D., and J. D. Stuart. 1994. Fire history and stand development of a Douglas-fir/hardwood forest in northern California. Northwest Science 68:205-212.

Wills, R.D. 1991. Fire history and stand development of Douglas-fir/hardwood forests in northern California. Thesis, Humboldt State University, Arcata, CA.

Wilson, C.C. and J.D. Dell. 1971. The fuels buildup in American forests: A plan of action and research. Journal of Forestry. August.

Wright, C.S. 1996. Fire history of the Teanaway River drainage, Washington. M.S. thesis, University of Washington, Seattle, WA.

Wright, K.A., L.M. Chapman and T.M. Jimerson. 1995. Using historic range of variability to develop desired conditions and model forest plan alternatives. Pp. 258-266 in: J.E. Thompson, compiler. Analysis in support of ecosystem management: Analysis workshop III. USDA Forest Service, Ecosystem Management Analysis Center, Washington, D.C.

Zedler, P. H. 1995. Fire frequency in southern California shrublands: biological effects and management options. Pages 101-112 in J. E. Keeley and T. L. Scott, (eds.) Brushfires in California: ecology and management. International Association of Wildland Fire, Fairfield, Washington, USA.